ECO nirman

Whole Building Performance

USER MANUAL

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ECOnirman

Whole Building Performance

USER MANUAL

September 2011

ECOnirman
Whole Building Performance

USER MANUAL

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How to use this manual

The following symbols and icons are used in this user manual:

Symbol/Icon	Description
§	Section of the user manual
*	Mandatory field
	External web link
	Useful tip
	Caution or warning

The text underlined in blue colour is a cross-reference within the user manual itself. Click it to open the section that is cross-referenced.

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1. Introduction

ECOnirman Whole Building Performance Tool is an online Conformance Check Tool for **Energy Conservation Building Code (ECBC)**. This manual will familiarize a user with the interface of ECOnirman Whole Building Performance Tool and walk through the step-by-step process of assessing conformance.

The Ministry of Power, Government of India, under the provision of the Energy Conservation Act, 2001 launched the Energy Conservation Building Code (ECBC) in May 2007. Since then, the Bureau of Energy Efficiency (BEE) has been promoting the implementation of the ECBC through several capacity building programs. United States Agency for International Development (USAID) supported Energy Conservation and Commercialization - Phase-III (ECO-III) Project has been working closely with BEE on these initiatives, and has developed **ECBC User Guide** and ECBC Tip Sheets (§ 2.1.1) for raising awareness on the ECBC among the stakeholders.

During these capacity building efforts, a strong need was felt to assist architects and engineers at the design stage so that they are able to assess and demonstrate the conformance of their proposed buildings with respect to the ECBC. It is with this objective that the development of **ECOnirman Whole Building Performance Tool**, using the **Whole Building Performance (WBP) Method** as per Appendix B of the ECBC, was undertaken by ECO-III Project Office in partnership with BEE. It is developed by The Weidt Group, Inc. (TWGI) under the guidance of ECO-III Project Office.

2. Key Concepts

Before using ECOnirman WBP Tool for assessing the conformance of the building, it will be beneficial to understand certain energy and conformance related concepts. These are explained in the following sub-sections.

See Appendix A: Definitions and Acronyms (§ 11) for a list of definitions.

2.1. Energy Performance Intensity (EPI)

Energy Performance Intensity (EPI) is defined as the annual energy consumption per square meter of the built-up area of the building. It is the ratio of the total energy used to the total built-up area and is expressed as kWh/m^2/year.

2.2. Energy Conservation Building Code (ECBC)

The Energy Conservation Building Code (ECBC) is the result of extensive work by BEE and its Committee of Experts. Its purpose is to provide minimum requirements for energy efficient design and construction of commercial buildings and their systems. It is the first step towards promoting energy efficiency in the building sector.

Refer to ECBC User Guide (International Standard Book Number 978-81-909025-3-3, BEE, New Delhi, India) to understand the ECBC better. It is available online at http://eco3.org/?file_id=1

2.2.1. ECBC Tip Sheets

The ECBC tip sheets created by ECO-III Project Office help in understanding the implications of the ECBC on different building components. The following four tip sheets are available for reference:

- **Energy Simulation:** http://eco3.org/?file_id=11
- **Building Envelope:** http://eco3.org/?file_id=19
- **Building Lighting Design:** http://eco3.org/?file_id=20
- **HVAC System:** http://eco3.org/?file_id=25

2.3. ECBC Conformance

Bureau of Energy Efficiency's intention is to facilitate the design and construction of the buildings conforming to the ECBC in India. The conformance process has been made flexible enough to help the designers and architects in meeting the ECBC requirements.

It is imperative for a building to first conform with the mandatory requirements stated in the ECBC. However, every building project is different: each building has its own site that presents unique opportunities and challenges, each building owner or user has different requirements, and climate and microclimate conditions can vary significantly among projects. Architects and engineers need flexibility in order to design buildings that address these diverse factors. The ECBC provides this flexibility in a number of ways. The building components and systems have multiple options to conform with the ECBC requirements.

Conformance with the ECBC can be achieved by meeting the Mandatory Requirements in the ECBC, in addition to either the Prescriptive Requirements using the Prescriptive Method (§ 2.3.1) or the requirements in the Whole Building Performance Method (§ 2.3.2).

Example: For the building envelope, designers can choose the Prescriptive Method that requires roof insulation be installed with a minimum R-value. Alternatively, the other options allow the designer to show conformance with the thermal performance (U-factor) of roof construction assembly. In addition, the building envelope trade-off option (as defined in Appendix D of the ECBC) permits trade-offs among building envelope components (roof, walls, and fenestration) for conformance with the ECBC. If more flexibility is needed, the Whole Building Performance Method is available.

2.3.1. Mandatory Requirements

The conformance procedure requires the buildings to fulfil a set of mandatory provisions related to energy use, as well as show conformance with the specified requirements stipulated for the different building components and systems.

2.3.2. Prescriptive Method

The Prescriptive Method of conformance specifies prescribed minimum energy efficiency parameters for various components and systems of the building. The conformance with the ECBC can be achieved by meeting or exceeding the specific levels described for each individual element of the building systems.

Refer to **ECOnirman Prescriptive Tool User Manual** (http://eco3.org/?file_id=232) to assess conformance using the Prescriptive Method.

2.3.3. Whole Building Performance Method

The Whole Building Performance (WBP) Method offers considerable design flexibility and allows for conformance with the ECBC to be achieved by optimizing the energy usage in various components and systems in order to find the most effective solution. The WBP Method requires the use of energy simulation software approved by the *Authority Having Jurisdiction* to simulate and compare the energy use of the *Proposed Design* and the *Standard Design* of the building.

Appendix B of the ECBC prescribes the protocol for developing a computer-based model for the purpose of energy simulation of the *Proposed Design* and the *Standard Design* of the building. Energy consumption of the *Standard Design* is the upper limit of energy use allowed for that particular building that meets all the *Prescriptive Requirements* applicable to that building. The conformance is achieved if the energy consumption of the *Proposed Design* is no greater than the energy consumption of the *Standard Design*. The following are the three basic steps involved:

- Design the building with energy efficiency measures; the prescriptive approach requirements provide a good starting point for the development of the design.
- Meet the applicable *Mandatory Requirements* of the ECBC.
- Demonstrate that the building conforms with the mandatory measures defined in the ECBC.
- Simulate the energy use of the building using the software approved by the *Authority Having Jurisdiction*. This is to be done by following the protocol in Appendix B to simulate the *Proposed Design* and the *Standard Design*.
- Compare the simulated energy use of the *Proposed Design* and the *Standard Design*.

If the energy consumption of the *Proposed Design* is no greater than the energy consumption of the *Standard Design*, the building conforms with the ECBC.

Energy Simulation Software

The use of energy simulation software is necessary to show conformance with the ECBC using the WBP Method. Energy simulation is a *computer-based analytical*

process that helps building owners and designers to evaluate the energy performance of a building before it is built and operated.

The energy simulation software can model the thermal, visual, ventilation, and other energy consuming processes taking place within the building to predict its energy performance. The software takes into account the building geometry and orientation, building materials, building façade design and characteristics, climate, indoor environmental conditions, occupant activities and schedules, Heating Ventilation and Air Conditioning (HVAC), lighting system, and other parameters to simulate the energy performance of the building.

Refer to **Energy Simulation** tip sheet available at http://eco3.org/?file_id=11 to learn more about building energy simulation.

3. ECOnirman Whole Building Performance Tool

ECOnirman Whole Building Performance Tool is an energy simulation software provided by BEE to assist architects and engineers in assessing the conformance of their buildings with the ECBC using the WBP Method. It is a web-based energy simulation tool that can be made available to the users over the Internet with minimal software requirements, building science, or simulation expertise. With minimal learning involved, a user having knowledge equivalent to that of a fifth-year architecture student with access to about one hour of HVAC engineer's time, can use the tool to demonstrate conformance with the ECBC.

A total of 1,294 city locations in India are represented in the tool. It has 46 weather files. Each city location and weather file has been assigned to the climate zone that it falls within on the basis of Geospatial Information System (GIS) mapping of the climate zones and the cities. When a city location for the building is chosen, the tool finds the closest available weather file within the same climate zone. This weather file is selected for the simulation.

The tool requires inputs about the building from the user. Based on the inputs, the tool runs simulation of the *Proposed Design* and the *Standard Design* as per Appendix B of the ECBC, and compares the EPI of simulation results. The results are presented after the simulation is completed. The tool also generates a report that may be submitted to the *Authority Having Jurisdiction* to demonstrate conformance with the ECBC.

3.1. Modelling Protocol and Default Inputs

ECOnirman WBP Tool follows the modelling protocol of Appendix B of the ECBC for developing the models of the *Standard Design* and the *Proposed Design*. The following logic is used:

- The details of the building are entered and the *Proposed Design* and the *Standard Design* are developed accordingly in the background as per the rules in Appendix B of the ECBC.
  Example: The user selects Daytime use or 24-hours use of the building and enters insulation values of the building materials. The tool determines the insulation values for the *Standard Design* based on the usage information entered and uses the material insulation values for the *Proposed Design*.

- The tool provides the defaults for the *Proposed Design* if its details are not specified by the user. These defaults are the same as those for the *Standard Design*.

  These defaults are provided across the tool for convenience only. It is important to provide actual building inputs to run the simulation correctly for assessing conformance.

3.2. Salient Features

- ECOnirman WBP Tool facilitates the users in assessing if a building meets the ECBC requirements for the five climatic zones in India.
- It generates a building's conformance report that compiles the data provided by the user and also indicates if the building is **conforming** or **not conforming** with the ECBC.
- It can store multiple building projects under a single user profile.
- It stores the information in a central database for future reference, review, edit, and analysis purposes.
- It allows the design teams to collaborate remotely.
- It keeps the information secured and confidential.
- It is available in a public domain (http://econirmanwbp.eetools.in) for easy access to the users.

3.3. Prerequisites

The following checklist of items (specific to the building being assessed for conformance with the ECBC) will come in handy while using the tool:

- Total interior floor area
- Marked-up plans by space types (see § 7.2.2 for examples)
- Floor area for each space type
- Perimeter lengths for each space type
- Lighting Power Density (LPD) values for each space type
- Space types marked as conditioned or unconditioned
- Ventilation requirements
- Mechanical equipment sizes and efficiencies
- Pump and fan static pressures
- Envelope construction assemblies (for walls, roofs, windows, and skylights) and shading

4. Tool Navigation

ECOnirman WBP Tool is aesthetically designed, keeping in mind the ease of navigation for the end-user.

The tool features different tabs at the top to navigate effectively through a project. These tabs feature sub-tabs (on the left side) that act as logical sections to enter the relevant building details to run the simulation and generate the conformance report.

For each building project, the user progresses by specifying the parameters including building shape, proportions, orientation, building use information, and details of the HVAC systems. When complete, the simulation can be invoked to view the results for both the *Standard Design* and the *Proposed Design*.

ECOnirman WBP Tool allows the users to provide inputs for the simulation that do not need to be sequential. The information can be provided in the sequence preferred by the user. This makes it more intuitive and interactive. However, to get correct results, the user needs to go through all the left tabs under each top tab and provide the information to make it relevant to the building.

Across the tool, the fields marked with an asterisk (*) are mandatory.

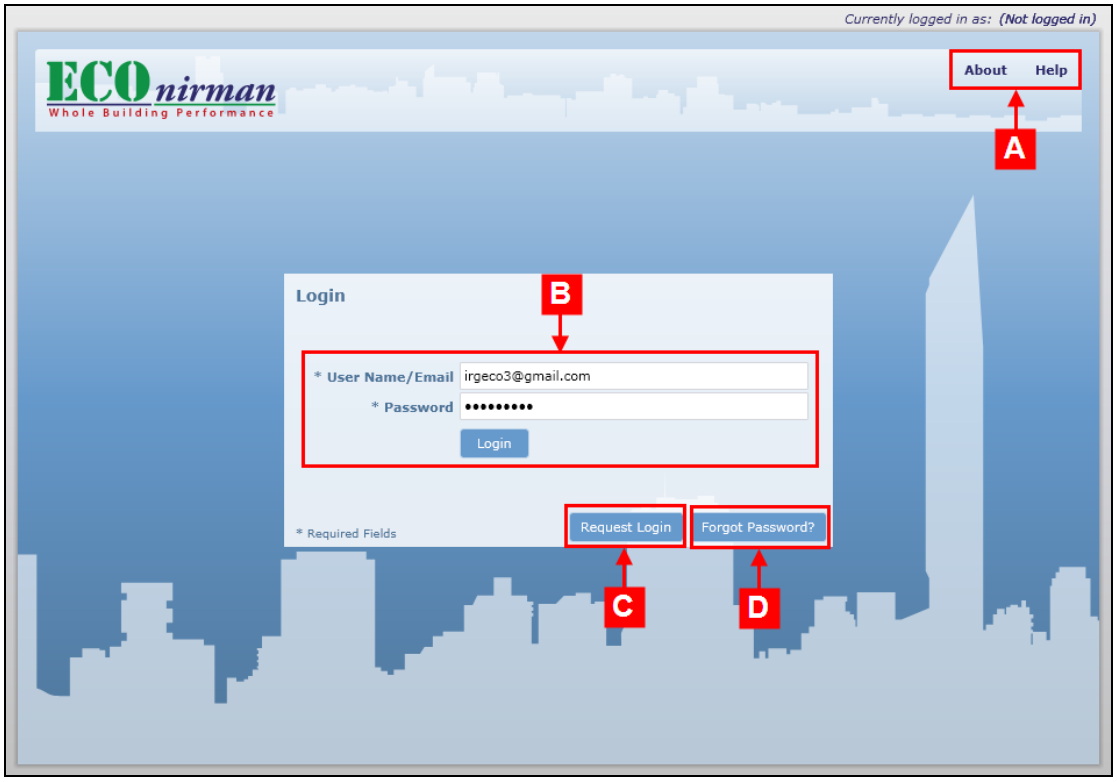
4.1. How to Access

Enter the link http://econirmanwbp.eetools.in in the web browser's address bar to access ECOnirman WBP Tool.

See Appendix C: Computer Settings (§ 13) to learn about the settings required on a user's computer before using ECOnirman WBP Tool.

4.2. Home Page

The following illustration highlights the composition of ECOnirman WBP Tool home page.



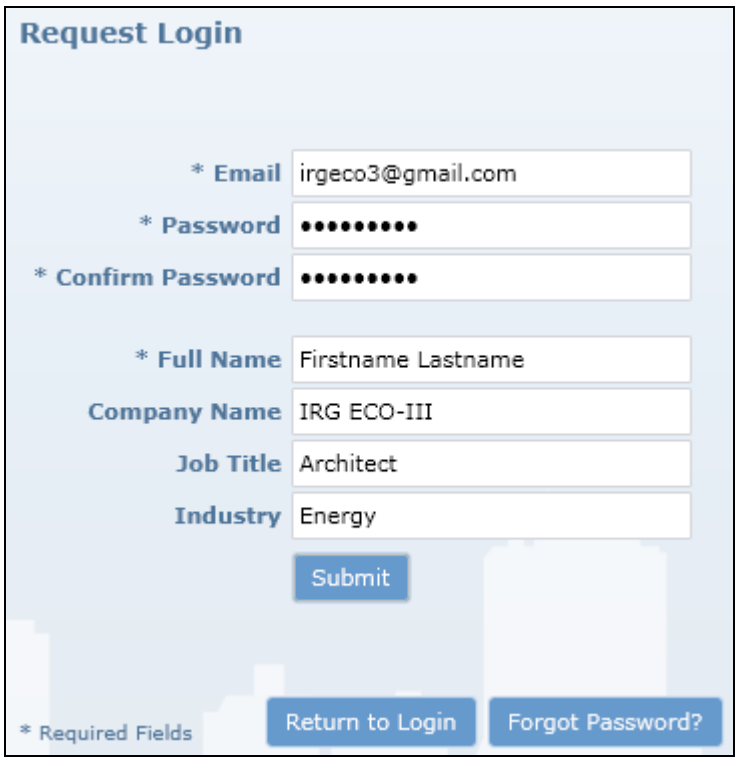
A	Click **About** to view the tool version and credits; click **Help** to view this user manual
B	Enter the user credentials and click **Login** to assess if a building and its components conform with the ECBC using the WBP Method (see § 4.3.2)
C	Click **Request Login** to register as a new user (see § 4.3.1)
D	Click **Forgot Password?** to retrieve a forgotten password (see § 4.3.3)

4.3. User Account

This section explains how to create a new user account, log into the tool, retrieve forgotten password, update user profile, and change password.

4.3.1. New User

Click **Request Login** on the home page to register as a new user. The **Request Login** dialog box appears.



- Enter a valid e-mail address.
- Enter a desired password and confirm it.
  Tip The password is case sensitive.
- Enter name and other details.
- Click **Submit** to create the user account.
- The **Projects** page opens. See § 5 to learn how to manage projects.

If an e-mail address is unavailable or invalid, a message appears at the top of the screen. Enter another e-mail address.

4.3.2. Log In

For an existing user, enter the registered e-mail address and password on the home page.

The password is case sensitive.

- Click **Log In** to log into ECOnirman WBP Tool.
- The **Projects** page opens. See § 5 to learn how to manage projects.

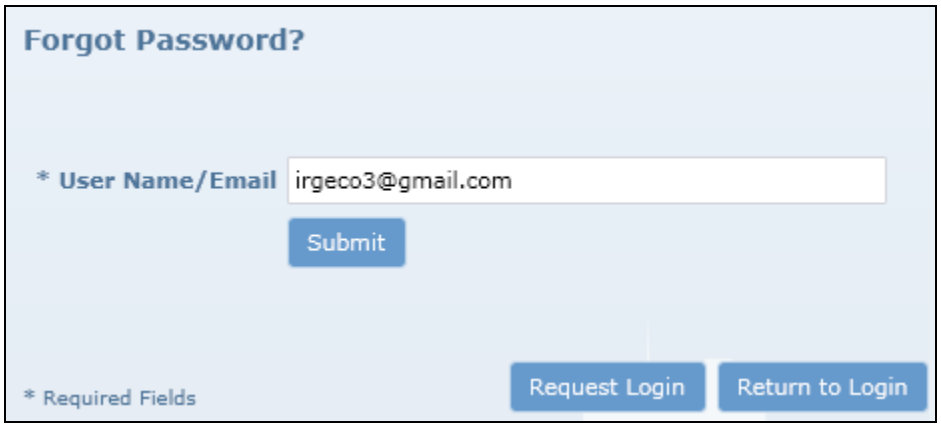
- Click **Request Login** at the bottom of the dialog box to create a new user account (see § 4.3.1).
- Click **Forgot Password?** at the bottom of the dialog box to retrieve a forgotten password (see § 4.3.3).

4.3.3. Retrieve Forgotten Password

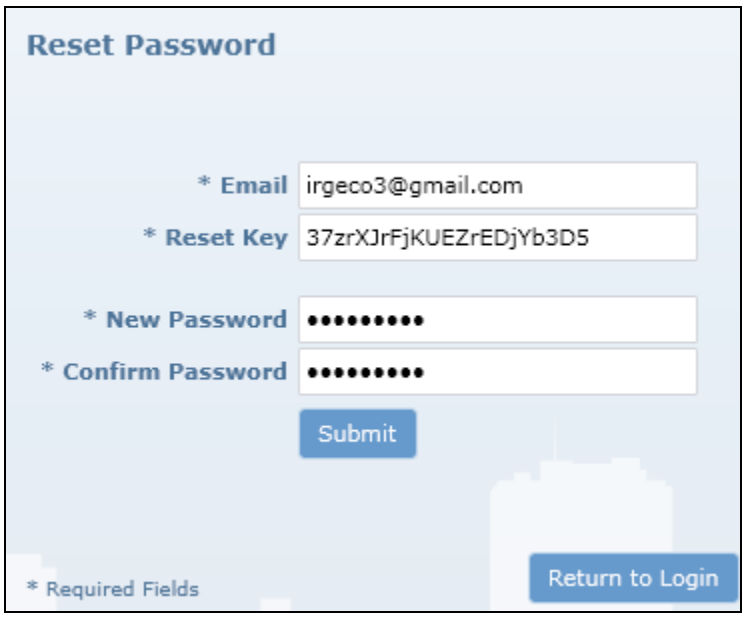
A forgotten password can be retrieved from any of the following two locations:

- **Request Login** dialog box (see § 4.3.1 New User)
- **Log In** dialog box (see § 4.3.2 Log in)

On the dialog box, click **Forgot Password?** to retrieve the password of an existing user. The **Forgot Password** dialog box appears.



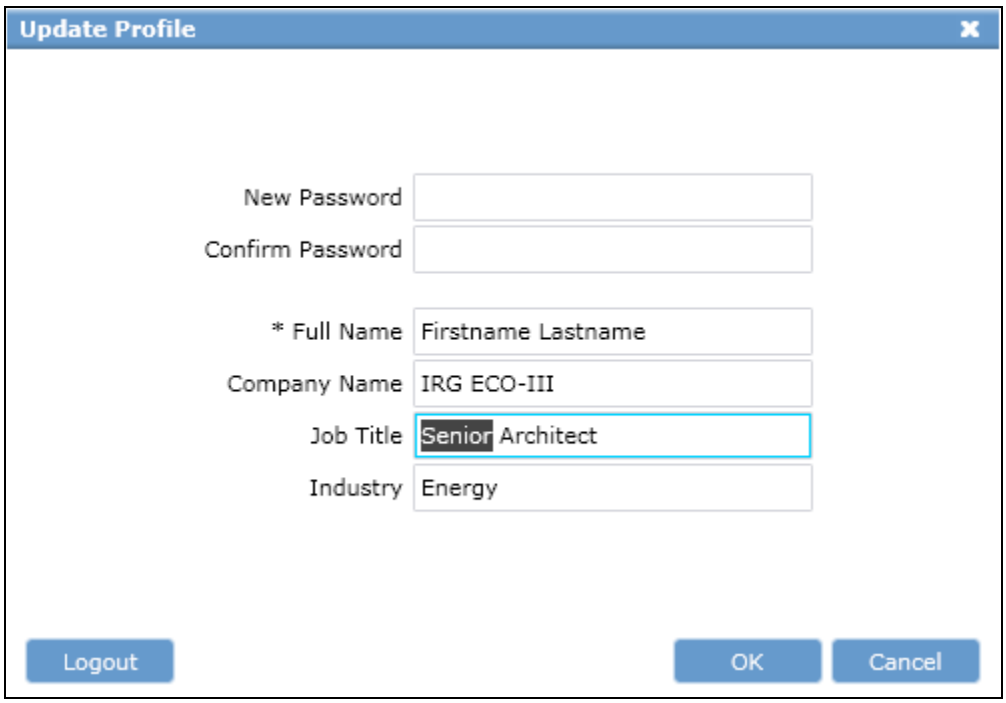
- Enter the registered e-mail address.
- Click **Submit** to send the request for password retrieval to the registered e-mail address.
- Open the e-mail (external of ECOnirman WBP Tool) and click the hyperlink available therein.
- The **Reset Password** dialog box appears in ECOnirman WBP Tool with the reset key auto-populated.



- Enter the new password and confirm it.
- Click **Submit** to reset the password.

4.3.4. Change Password and Update Profile

Click on logged in user's e-mail address at the top right corner of the screen to change the password or update the user details. The **Update Profile** dialog box appears.



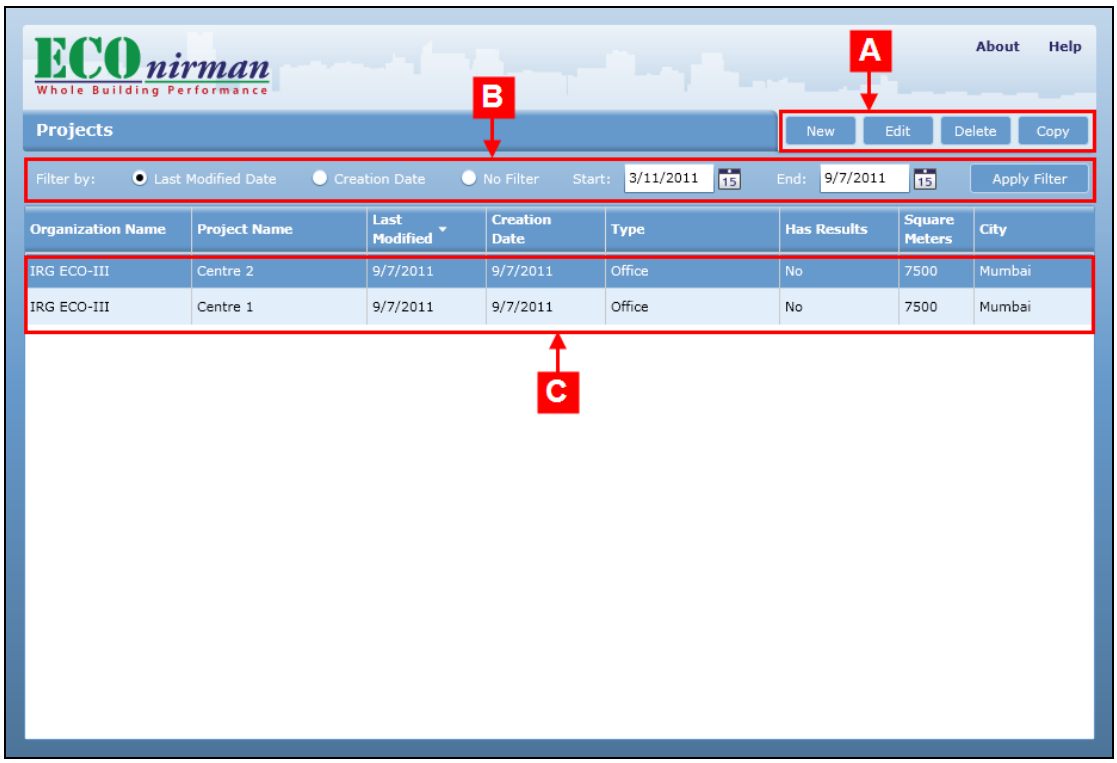
- To change the password, enter the new password, confirm it, and click **OK**.
- To update the profile, enter the relevant details and click **OK**.

4.3.5. Log Out

After using the tool (or at any point), click **Logout** at the top right corner of the screen to log out of ECOnirman WBP Tool. A dialog box appears.

5. Manage Projects

After logging into ECOnirman WBP Tool for the **first time**, a blank project list is displayed. However, if the project records were **already created** by logging in earlier, then those are listed.



The following is the composition of the page:

A	Actions:
	• Create new project (see § 5.1.1)
	• Existing project:
	  ◦ Edit (see § 5.1.2)
	  ◦ Delete (see § 5.1.3)
	  ◦ Copy (see § 5.1.4)

B	Filter the list of projects (see § 5.2)
C	The list of projects

Tip The project list can be sorted by clicking the column heading. For example, click the column heading **Has Results** to view the projects sorted as per the availability of results of the simulation to assess conformance. **Yes** indicates that simulation results are available for the project and **No** indicates that they are not.

5.1. Project Actions

The building projects can be created, edited, deleted, and copied. These actions are explained in the following sub-sections.

5.1.1. Create Project

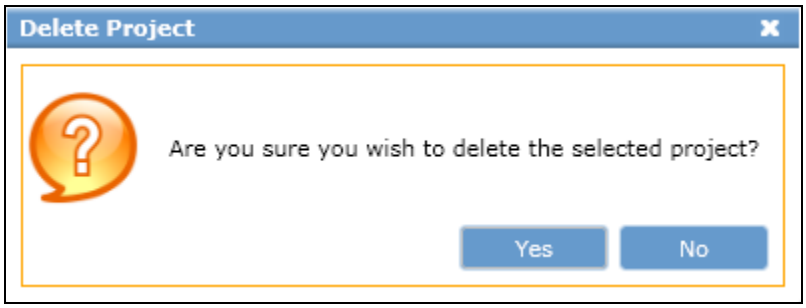
To create a new project for assessing conformance, click **New** at the top right corner of the screen. The Project Information tab opens (see § 6).

5.1.2. Edit Project

To edit an existing project, click on a project in the list and then click **Edit** at the top right corner of the screen. The Project Information tab opens with the underlying project details (see § 6).

5.1.3. Delete Project

To delete an existing project, click on a project in the list and then click **Delete** at the top right corner of the screen. A confirmation dialog box appears.



Click **Yes** to delete the project. The project gets delisted.

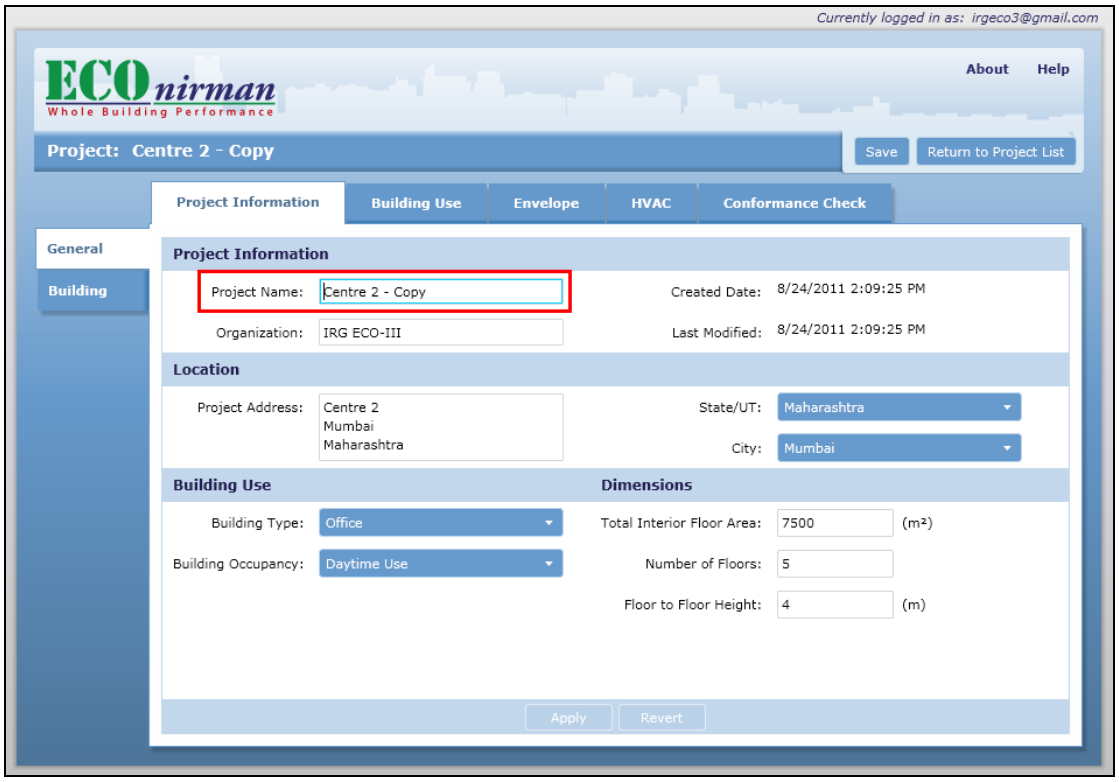
There is no way to undo this action and retrieve a deleted project.

5.1.4. Copy Project

To make a copy of an existing project, click on a project in the list and then click **Copy** at the top right corner of the screen.

- The General sub-tab (§ 6.1) under **Project Information** tab opens.

- The project name in the **Project Name** field is suffixed with the word '**copy**'. Change this (if required).
- Click **Save** at the top right corner of the screen.



The copy of the project is created with all the information from the original project retained as is.

5.2. Filter Project List

The projects in the list can be filtered to view only the relevant ones. This feature is particularly useful as the number of projects increase and the list gets bigger.

The following two date filters are available:

Last Modified Date	The date on which an existing project was last modified
Creation Date	The date on which a new project was created

- Select the radio button corresponding to the desired date filter.
- Define the date range:
  - To set the start date, click 15 corresponding to **Start**. Select the date from the calendar that appears.

- To set the end date, click corresponding to **End**. Select the date from the calendar that appears.

Click or to navigate to the previous or the next calendar month respectively.

- Finally, click **Apply Filter** to set the filter. Only the projects within the defined date range get listed.

Select **No Filter** radio button to remove the set filter.

6. Project Information

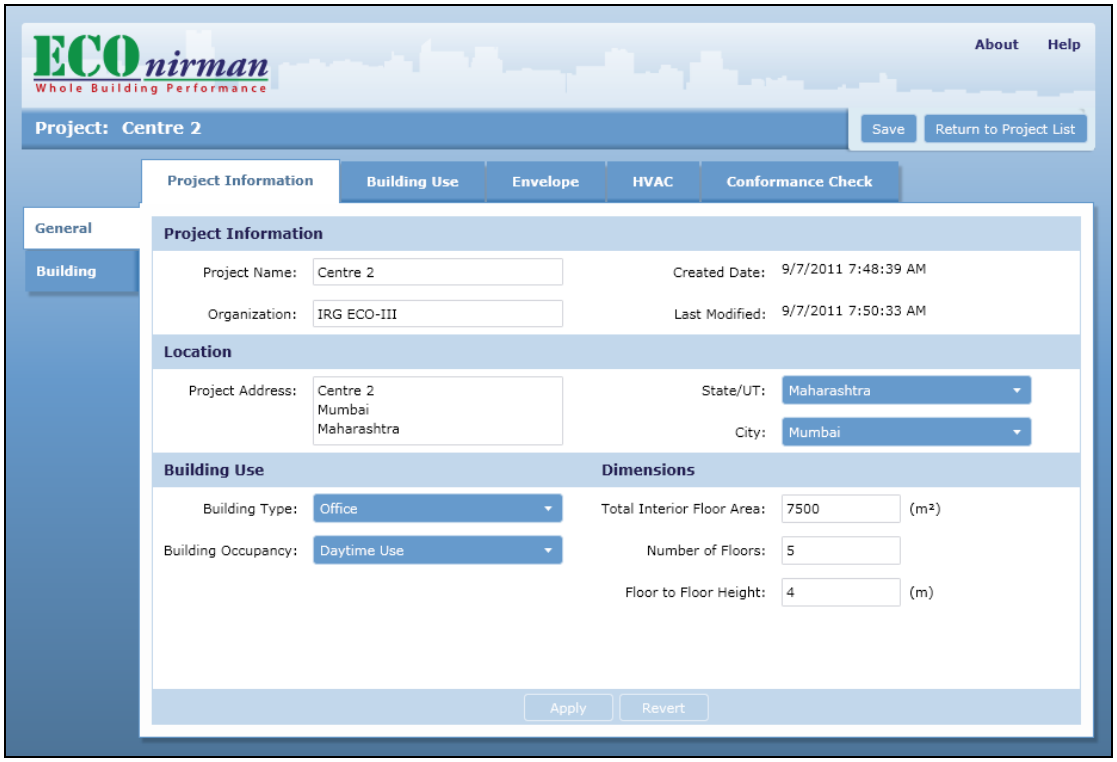
The **Project Information** tab opens upon clicking New, Edit, or Copy on the Projects page. The tab comprises of two vertical sub-tabs that are explained in the following sub-sections.

Certain input fields get customized across the tool according to the details entered under these sub-tabs.

6.1. General

This sub-tab opens by default and is used to capture the name, location, and basic information of the building.

It is important to enter the correct information on this sub-tab before proceeding any further. Making changes on this sub-tab after providing inputs elsewhere in the tool will reset the defaults for the project. All the inputs across the tool will be lost.



- Enter/edit the details such as project and organization names, location details, building details (type and occupancy), and dimensions.

  Enter the exact **Total Interior Floor Area** of the building. Certain input fields get defaulted across the tool based on this information.

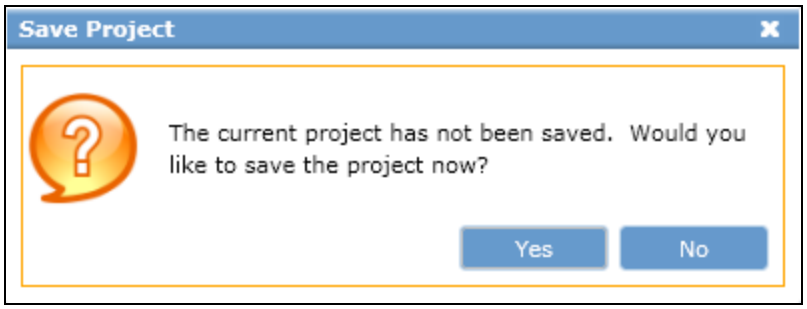
- Click **Apply** at the bottom of the screen.

At this point:

- The creation and modification dates along with the timestamps are displayed.
- Other tool tabs and sub-tabs get activated.

Revert is used to discard the entered details and revert to the previously **saved** ones.

Click **Return to Project List** available at the top right corner of the screen at any point to access the list of projects. A dialog box appears to save the details.



Click **Yes** to save the details.

It is imperative to save the entered details before accessing the list of project. Any unsaved details under the tabs/sub-tabs will be lost otherwise.

6.2. Building

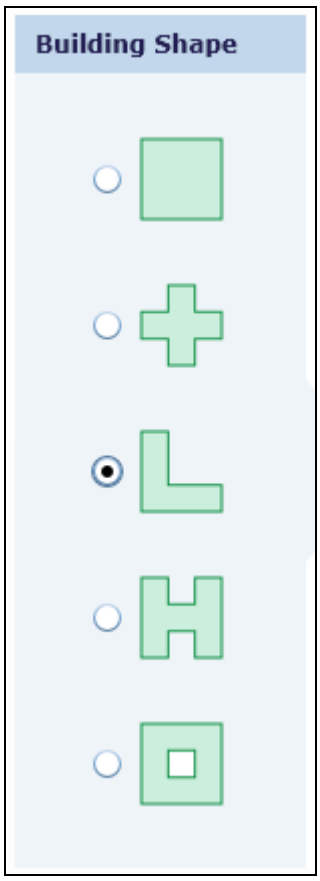
This sub-tab is used to define the shape, orientation, and dimensions of the building.

The building geometry inputs can be specified by selecting a building floor plan shape, and modifying the proportions and orientation to represent the building to be assessed for conformance.

To keep the inputs easy, five typical building plan shapes are provided in the tool (see § 6.2.1). A shape can be customized by modifying the dimensions (see § 6.2.2). Also, the orientations can be defined at 45° increments by rotating the shape (see § 6.2.3).

6.2.1. Building Shape

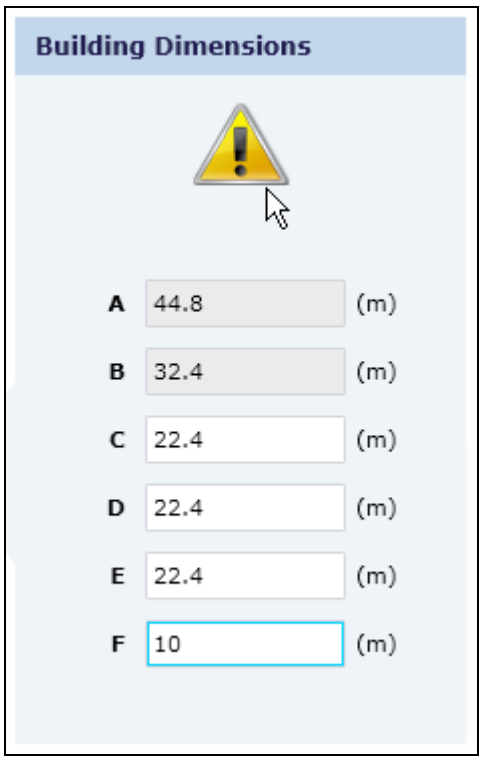
Select the shape of the building from the available five options.



6.2.2. Building Dimensions

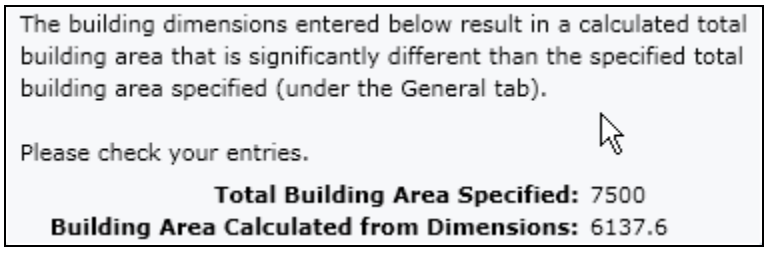
The dimensions are displayed on the basis of the selected building shape. Change the values to customize the dimensions.

If the calculated area while customizing the dimensions does not reconcile with that defined under the General sub-tab (§ 6.1), a warning icon is displayed.



To resolve:

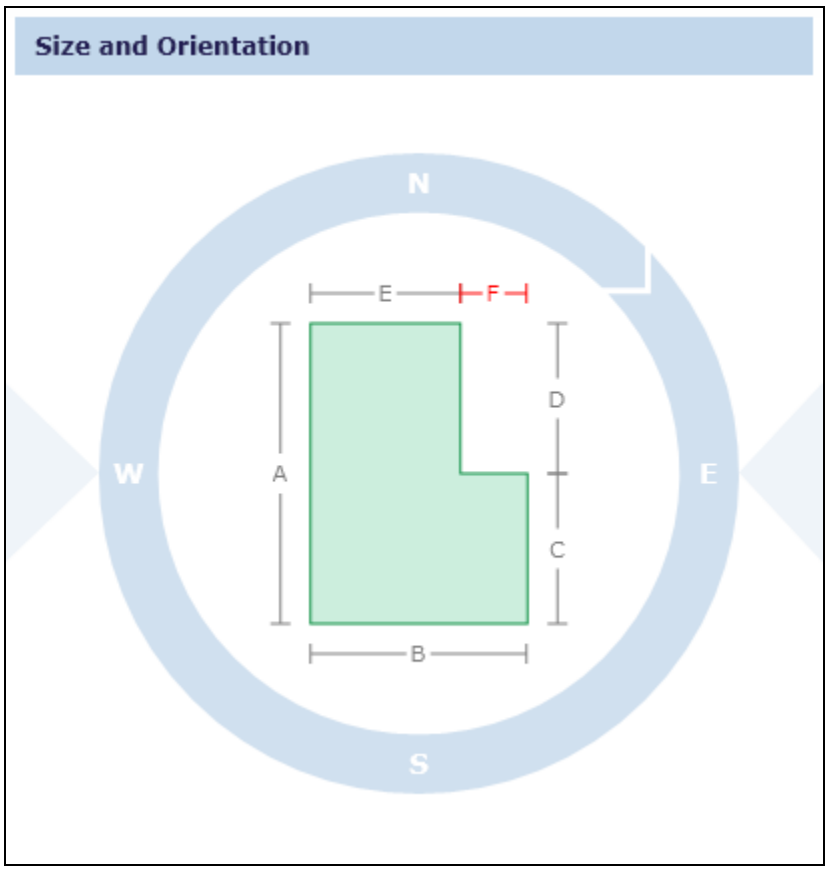
- Hover the mouse pointer over the icon to read the warning message. It displays **Total Building Area Specified** and **Building Area Calculated from Dimensions**.


The building dimensions entered below result in a calculated total building area that is significantly different than the specified total building area specified (under the General tab).
Please check your entries.
Total Building Area Specified: 7500
Building Area Calculated from Dimensions: 6137.6

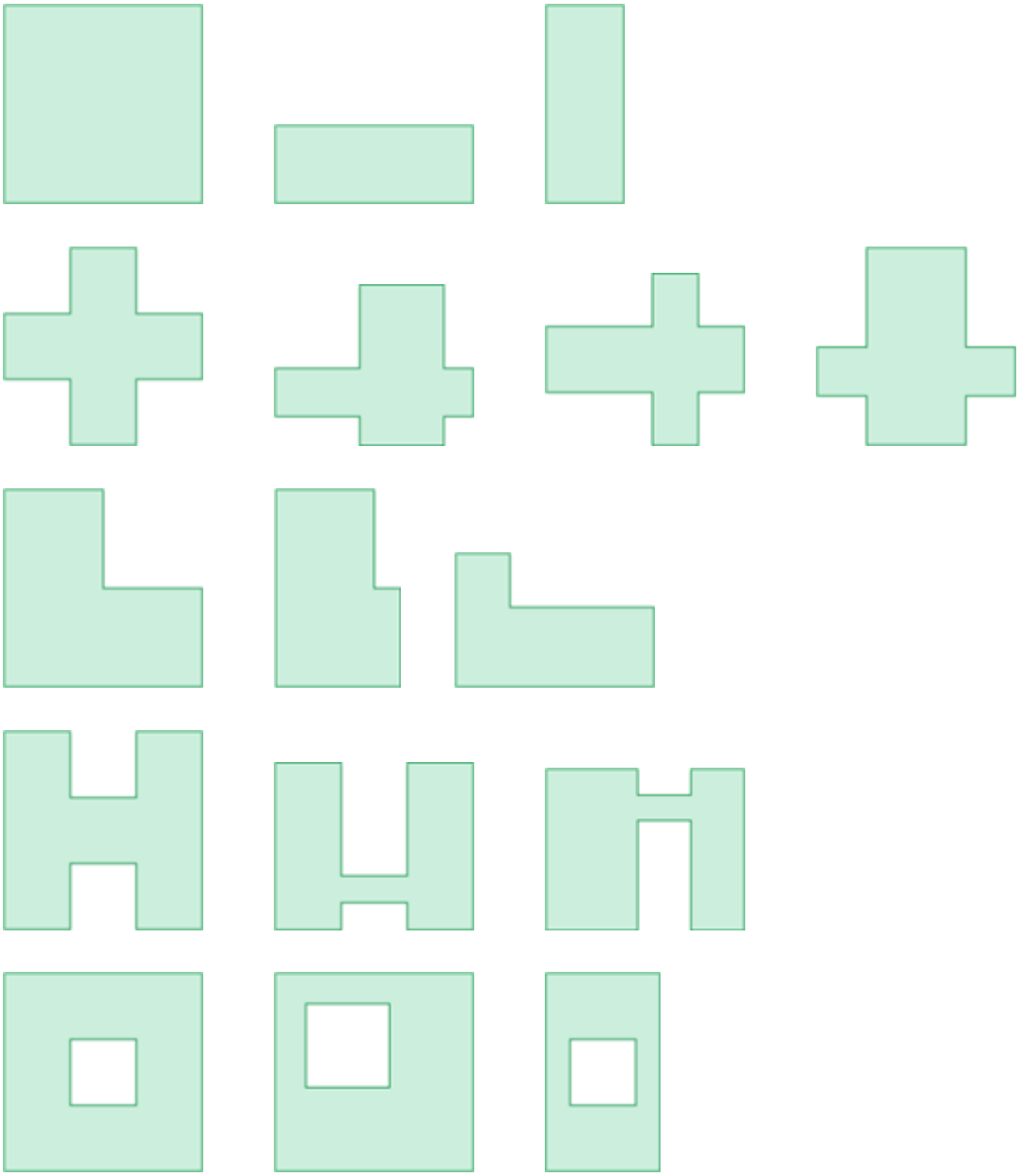
- Assess the variance.

- Make appropriate corrections so that the area defined under both the sub-tabs match.

When the customized dimensions are being defined, those proportionately and dynamically also keep changing in the graphic in the center of the page.



The following are certain examples of building shapes derived by modifying the dimensions:

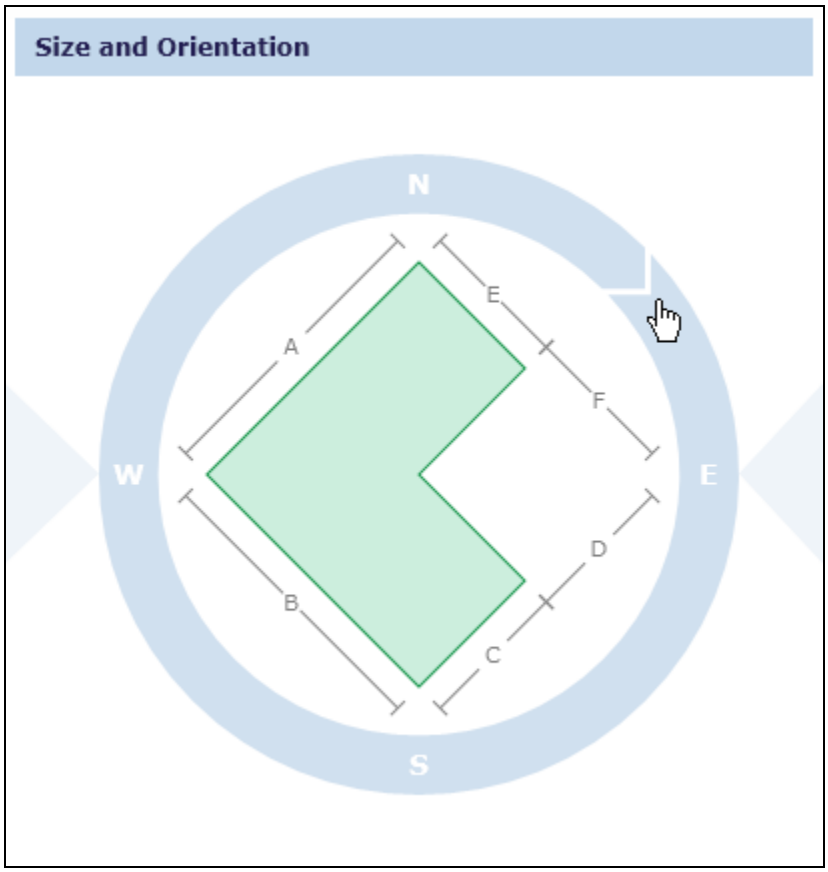


6.2.3. Building Orientation

The orientation of the building can be defined by rotating the building clock-wise at 45° intervals. To rotate, click the white arrow and simultaneously drag the mouse pointer clock-wise.

The building can be oriented in the following eight cardinal/ordinal directions:

- North
- North-East
- East
- South-East
- South
- South-West
- West
- North-West



7. Building Use

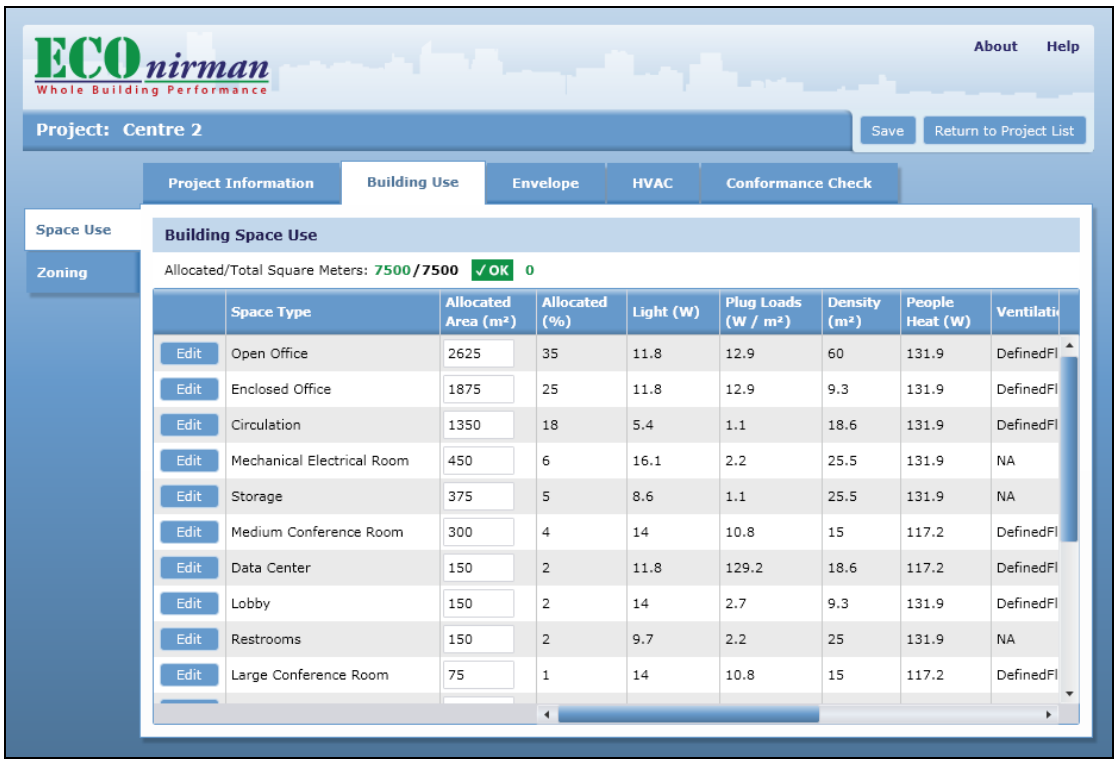
Click **Building Use** tab to define space use and zoning. The tab comprises of two vertical sub-tabs that are explained in the following sub-sections.

Certain input fields get customized across the tool according to the details entered under these sub-tabs.

7.1. Space Use

This sub-tab is used to define the area allocated to each space type and the corresponding loads, lighting details, thermal comfort, and operating schedules.

A key task in modelling the *Proposed Design* is assigning space use classifications to different areas of the building. These classifications are used to assign lighting power density assumptions and to differentiate areas within the building that may have different operating schedules and characteristics (for example, thermostat settings and ventilation rates).


ECOnirman
Whole Building Performance
About
Help
Project: Centre 2
Save
Return to Project List
Project Information
Building Use
Envelope
HVAC
Conformance Check
Space Use
Zoning
Building Space Use
Allocated/Total Square Meters: 7500/7500 ✓OK 0
Space Type | Allocated Area (m²) | Allocated (%) | Light (W) | Plug Loads (W / m²) | Density (m²) | People Heat (W) | Ventilati
Edit | Open Office | 2625 | 35 | 11.8 | 12.9 | 60 | 131.9 | DefinedFl
Edit | Enclosed Office | 1875 | 25 | 11.8 | 12.9 | 9.3 | 131.9 | DefinedFl
Edit | Circulation | 1350 | 18 | 5.4 | 1.1 | 18.6 | 131.9 | DefinedFl
Edit | Mechanical Electrical Room | 450 | 6 | 16.1 | 2.2 | 25.5 | 131.9 | NA
Edit | Storage | 375 | 5 | 8.6 | 1.1 | 25.5 | 131.9 | NA
Edit | Medium Conference Room | 300 | 4 | 14 | 10.8 | 15 | 117.2 | DefinedFl
Edit | Data Center | 150 | 2 | 11.8 | 129.2 | 18.6 | 117.2 | DefinedFl
Edit | Lobby | 150 | 2 | 14 | 2.7 | 9.3 | 131.9 | DefinedFl
Edit | Restrooms | 150 | 2 | 9.7 | 2.2 | 25 | 131.9 | NA
Edit | Large Conference Room | 75 | 1 | 14 | 10.8 | 15 | 117.2 | DefinedFl

Some space types are defaulted to be unconditioned, which can be modified. Unconditioned zones are modelled identically in the *Standard Design* and the *Proposed Design* models. The following is the modelling method:

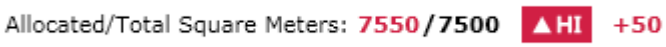
- All unconditioned thermal zones have their cooling set points as 50°C and heating set points as 8°C.
- All unconditioned thermal zones are assigned to one air handling unit (AHU).

Thus, the cooling and the heating for the AHU with unconditioned zones are not activated by the simulation engine in the simulation run.

7.1.1. Area Allocation

Against each space type, enter the area to be allocated to it under the **Allocated Area (m^2)** column.

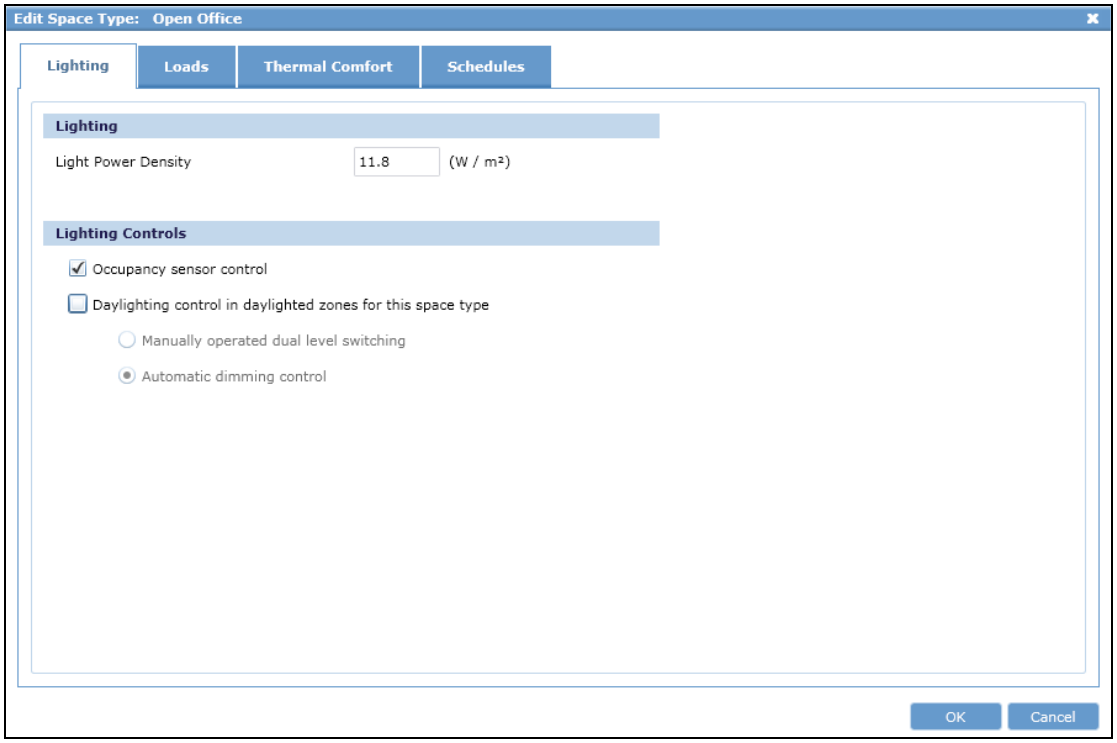
The total area allocated to all the space types must be equal to the **Total Interior Floor Area** defined under the General sub-tab (§ 6.1) of **Project Information**. If it is higher or lower, a message is displayed with the variance:



7.1.2. Lighting

Click **Edit** corresponding to a space type to edit its corresponding lighting details. The **Edit Space Type** dialog box appears with the default lighting details.

It is important to replace the defaults with the inputs that match the actual building design in order to get the correct simulation results for conformance.

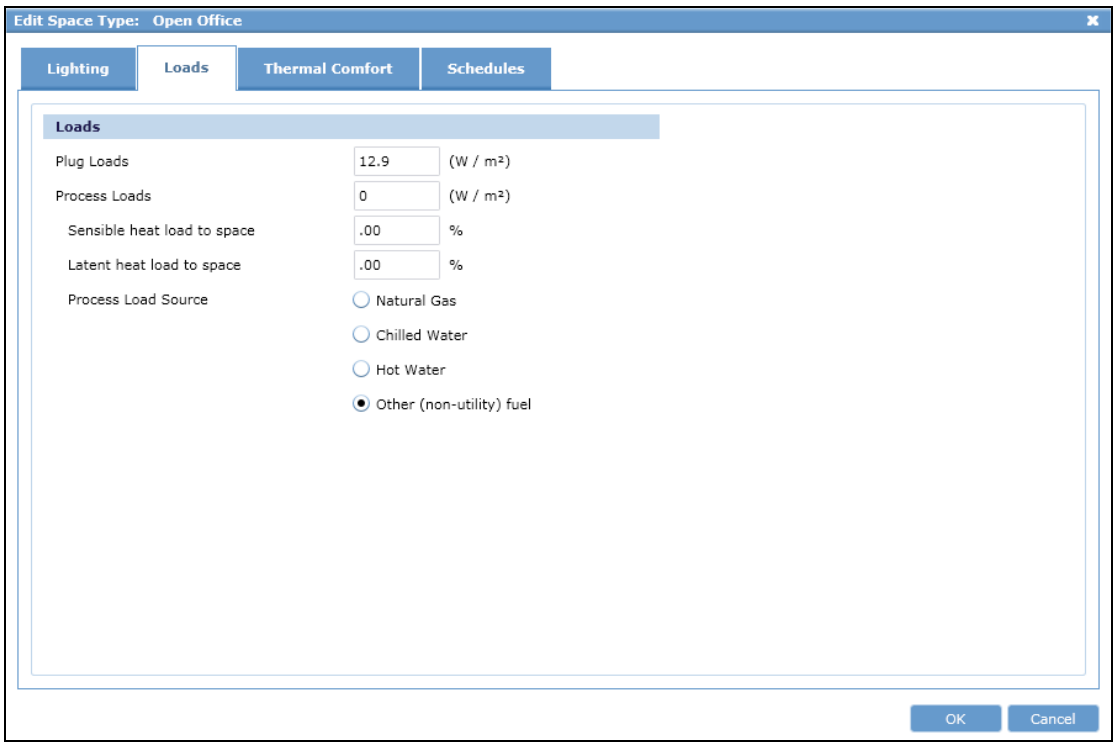


- Define lighting power density (LPD).
- Enter the details of lighting controls.
- Click **OK** to set the lighting details.

7.1.3. Loads

Click **Edit** corresponding to a space type to edit its corresponding loads. The **Edit Space Type** dialog box appears. Click the **Loads** tab.

Enter these loads to get a more accurate prediction of the overall energy use of the building. If there is a doubt on these loads, leave the defaults in place. These loads are identical in both the *Proposed Design* and the *Standard Design* models, and therefore do not influence the energy efficiency of the design.



- Define the plug and process loads.
  - Enter the Plug Loads (power density for the equipment that is plugged into the electrical outlets).
  - For equipment that uses forms of energy other than electricity and release heat into the space type, enter the Process Loads.

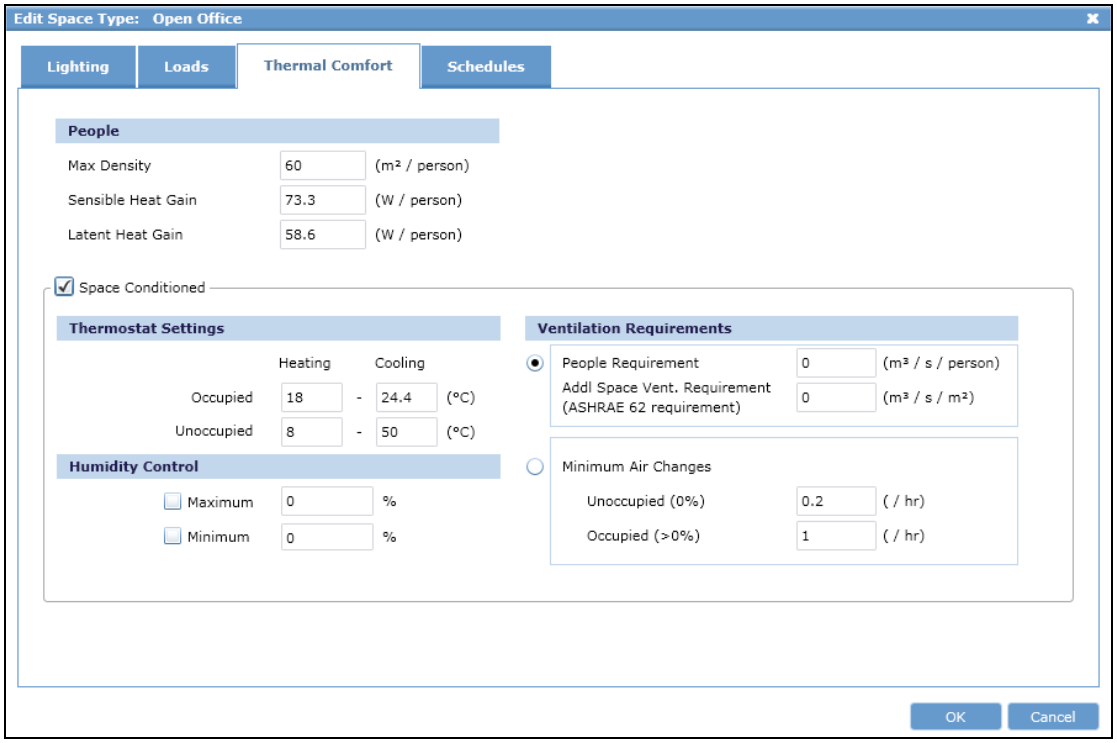
- Click **OK** to set the loads.

7.1.4. Thermal Comfort

According to Appendix A of the ECBC, the floor area of a building is categorized as following:

- **Conditioned space:** This is a cooled space, heated space, or directly conditioned space in the building.
- **Semi-heated/cooled space:** This is an enclosed space within a building that is heated by a heating system whose output capacity is greater than or equal to 10.7 W/m2 of floor area but is not a conditioned space.
- **Unconditioned space:** This is neither conditioned space nor semi-heated space. Crawl spaces, attics, and parking garages with natural or mechanical ventilation are not considered as enclosed spaces.

Click **Edit** corresponding to a space type to edit its corresponding thermal comfort details. The **Edit Space Type** dialog box appears. Click the **Thermal Comfort** tab.



- Define people related details.

  Leave the defaults in place if this information is not available.

- Define conditioned space details (optional) such as thermostat settings, humidity control, and ventilation requirements.

It is important to replace these defaults with the inputs that match the actual building design in order to get the correct simulation results for conformance.

- Click **OK** to set the thermal comfort.

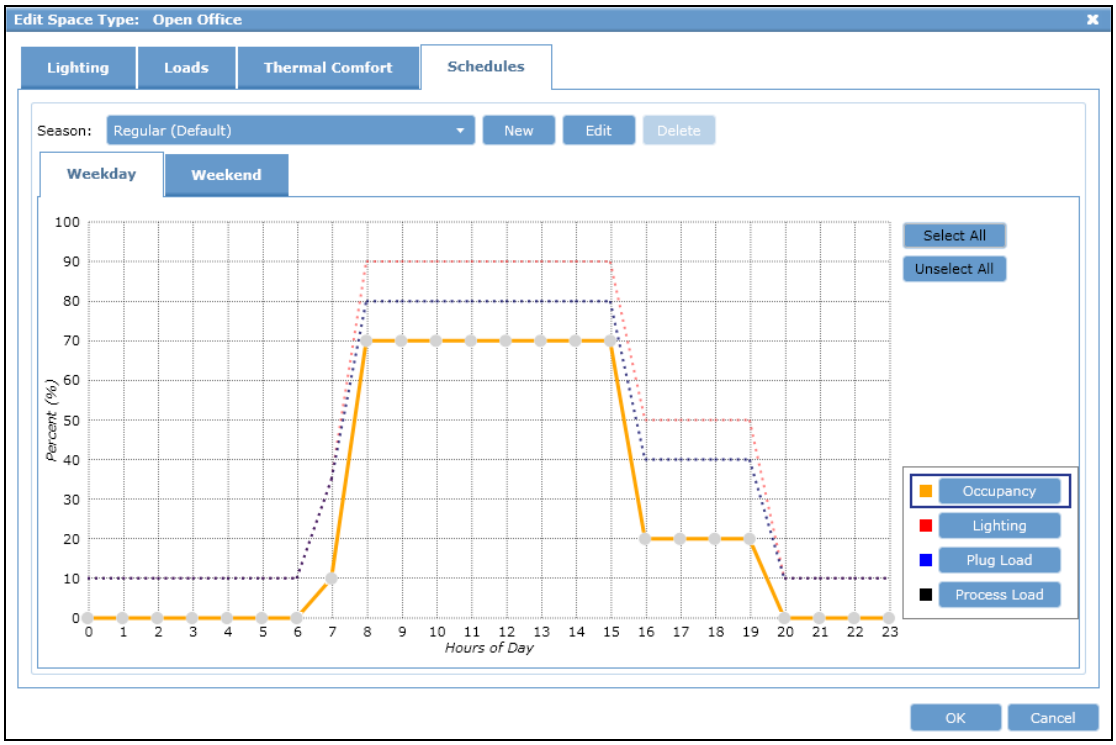
7.1.5. Schedules

Schedules are used to define an hour-by-hour value that represents the percentage of the maximum internal load. It applies to lighting power density, miscellaneous equipment (plug load or process load) power density, and building occupancy.

Schedules can have a large impact on the energy consumption. The user needs to specify weekday (Monday-Friday) and weekend (Saturday and Sunday) operations in each schedule.

ECOnirman WBP Tool simulates the *Proposed Design* and the *Standard Design* with identical schedules.

Click **Edit** corresponding to a space type to edit its corresponding operating schedules. The **Edit Space Type** dialog box appears. Click the **Schedules** tab.

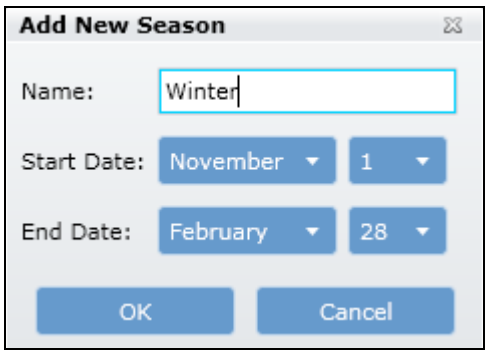


Season

Select a season from the drop-down menu.

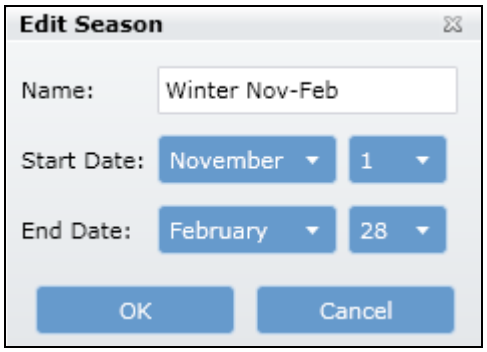
Regular (Default) is the default season, which cannot be deleted.

To create a new season, click **New**. The **Add New Season** dialog box appears.



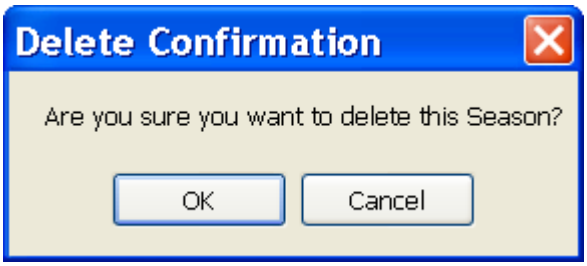
- Enter the name of the season.
- Define the period (start and end months/days).
- Click **OK**.

To edit a season, select it from the drop-down menu and click **Edit**. The **Edit Season** dialog box appears.



Make the changes and click **OK**.

To delete a season, select it from the drop-down menu and click **Delete**. A confirmation dialog box appears.



Click **OK** to delete the season. The season gets delisted from the drop-down menu.

Days

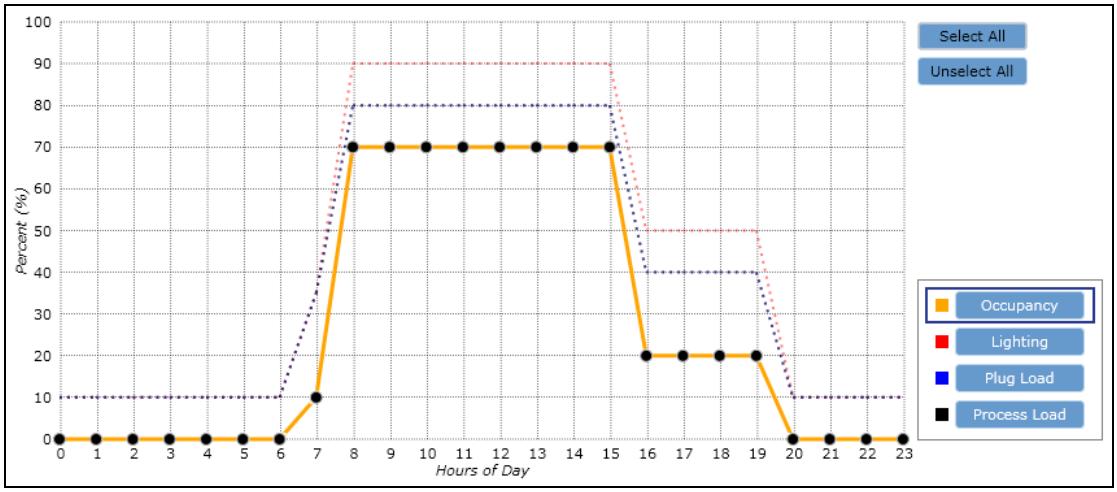
Toggle between **Weekday** (Monday-Friday) and **Weekend** (Saturday and Sunday) tabs to view the relevant schedules.

Schedule

The schedule is plotted for the following four categories:

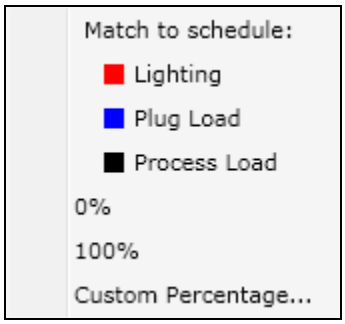
- Occupancy
- Lighting
- Plug Load
- Process Load

Select a category to view its pattern during the 24 hours of the day.


Select All
Unselect All
Occupancy
Lighting
Plug Load
Process Load
Percent (%)
Hours of Day
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
0 10 20 30 40 50 60 70 80 90 100

The selected category is represented by a solid line, whereas the other three are represented by dotted lines.

- Select hour-based data point(s) and drag the mouse pointer to change the pattern.
- Click **Select All** to select all the data points (all 24 hours).
- Click **Unselect All** to unselect the selected data point(s).
- Select hour-based data point(s) and right-click on the mouse. A context menu appears.



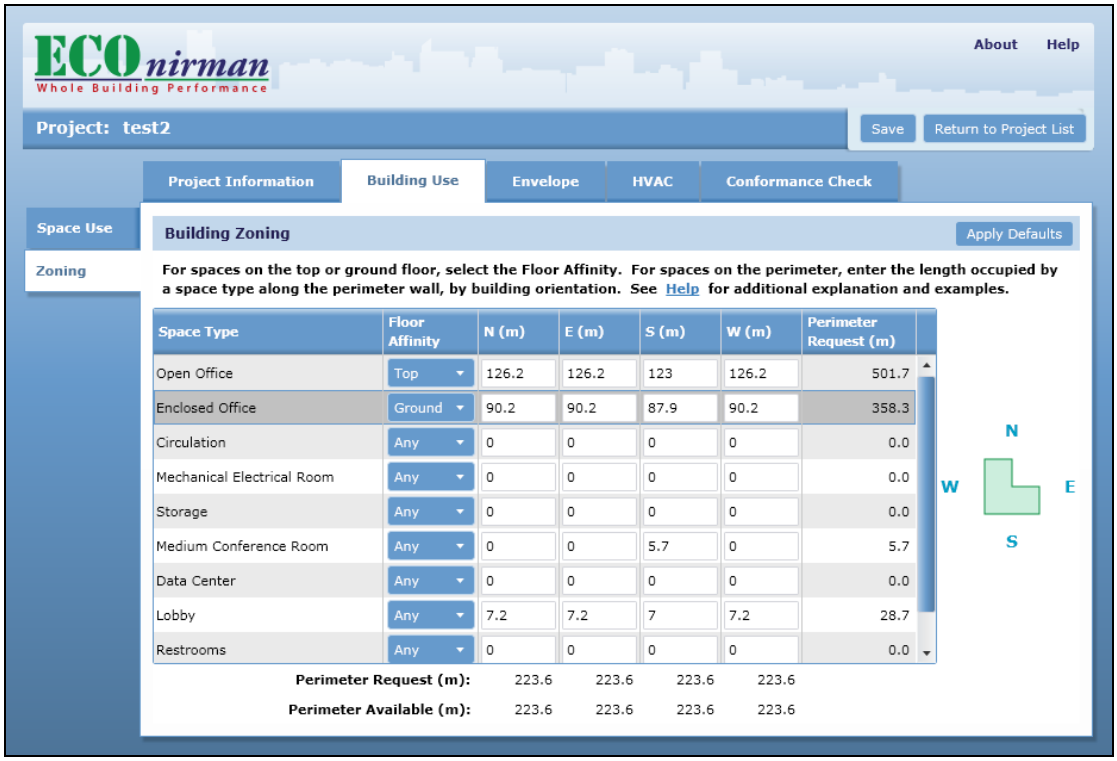
  - Select a category under **Match the schedule** to match the selected hour-based data point(s) to that category's hour-based data point(s).
  - Select **0%** to set the selected hour-based data point(s) to 0%; select **100%** to set the selected hour-based data point(s) to 100%; select **Custom Percentage** to define a customized percentage for the selected hour-based data point(s).

7.2. Zoning

This sub-tab is used to provide minimal information so that ECOnirman WBP Tool can generate the thermal zones of the building.

ECOnirman WBP Tool uses the building geometry (shapes, proportions, and orientations), the specified space types, and zoning affinities to create zones for both the *Proposed Design* and the *Standard Design* models.

Click the **Zoning** sub-tab to define the zones.


ECOnirman
Whole Building Performance
About
Help
Project: test2
Save
Return to Project List
Project Information
Building Use
Envelope
HVAC
Conformance Check
Space Use
Zoning
Building Zoning
Apply Defaults
For spaces on the top or ground floor, select the Floor Affinity. For spaces on the perimeter, enter the length occupied by a space type along the perimeter wall, by building orientation. See Help for additional explanation and examples.
Space Type
Floor Affinity
N (m)
E (m)
S (m)
W (m)
Perimeter Request (m)
Open Office Top 126.2 126.2 123 126.2 501.7
Enclosed Office Ground 90.2 90.2 87.9 90.2 358.3
Circulation Any 0 0 0 0 0.0
Mechanical Electrical Room Any 0 0 0 0 0.0
Storage Any 0 0 0 0 0.0
Medium Conference Room Any 0 0 5.7 0 5.7
Data Center Any 0 0 0 0 0.0
Lobby Any 7.2 7.2 7 7.2 28.7
Restrooms Any 0 0 0 0 0.0
Perimeter Request (m): 223.6 223.6 223.6 223.6
Perimeter Available (m): 223.6 223.6 223.6 223.6
N
W
E
S

The auto-populated perimeter lengths are provided for convenience only. However, it is important to provide inputs that represent the actual building to create the zones correctly.

7.2.1. Floor Affinity

Select **Floor Affinity** (**Any**, **Ground**, **Top**) for the space type from the drop-down menu adjacent to each space type.

- **Any:** This sets the zone(s) of the respective space type be placed on any floor within the building

- **Ground:** This sets a priority for the zone(s) of the respective space type to be placed on the ground floor of the building.
- **Top:** This sets a priority for the zone(s) of the respective space type to be placed on the upper level, or the top floor of the building.

7.2.2. Perimeter Allocation

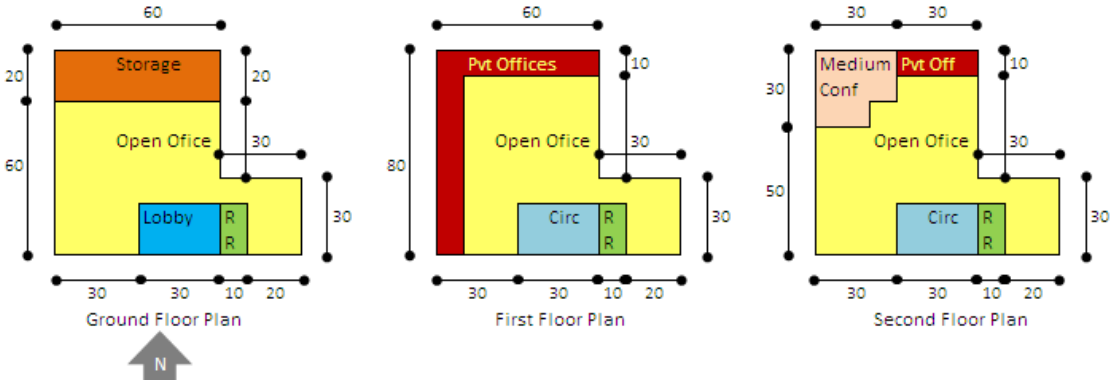
Click **Apply Defaults** to set the default values for the space types for the selected building shape and the area allocated under the Building sub-tab (§ 6.2). However, if this is clicked after any changes are made under the **Zoning** sub-tab, then those **changes will be lost** and the defaults will be re-applied.

Perimeter orientation affinities: Perimeter zones in the model need to reflect the perimeter space types that are along the exterior walls in the building. To achieve this:

- Mark up the plans to classify the rooms by space types (see example below).
- Mark up the perimeter lengths of the spaces.
- Add the total length of a space type along each orientation and enter the sum in the zoning table.

Example:

The following are the illustrations of a 3-storied building with its plans marked up as space type along with the dimensions of the length occupied by each space type on the perimeter.



The following table depicts how floor affinities and perimeter affinities are calculated from the plans above.

Floor Affinity: Since Lobby and Storage are only on the ground floor, they get **Ground** as the floor affinity. The Medium Conference is only on the top floor, so it gets **Top** as the floor affinity.

Perimeter Affinity: For each orientation, add up the linear exposed length for a space type and enter it in the corresponding cell. On the South face, the circulation has 30 m on the first floor and 30 m exposed on the second floor. Therefore, the perimeter affinity for Circulation on the South is 30 m + 30 m = 60 m.

Space Type	Floor Affinity	North (m)	East (m)	South (m)	West (m)
Open Office	Any		60	20 + 30 + 20 + 20 + 30 + 20	30 + 30 + 40 + 30 + 40 + 30
Private Offices	Any	60 + 30	80 + 50	10	10 + 10
Circulation	Any			30 + 30	
Medium Conference	Top	30	30		
Rest Rooms	Any			10 + 10 + 10	
Storage	Ground	60	20		20
Lobby	Ground			30	

8. Envelope

The building envelope refers to the exterior façade and roof and is comprised of opaque components and fenestration systems. Opaque components include walls and roofs. Fenestration systems include windows and skylights. The envelope protects the building's interior and occupants from the weather conditions and shields them from other external factors such as noise and air pollution.

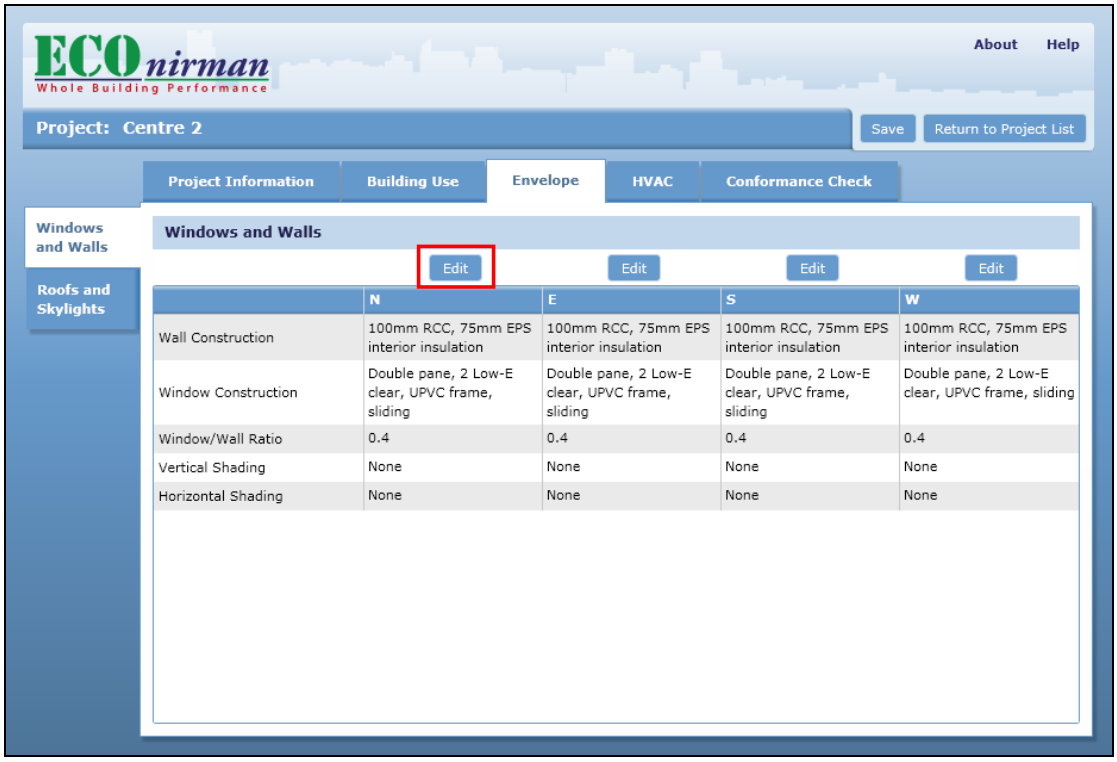
Envelope design strongly affects the visual and thermal comfort of the occupants, as well as the energy consumption in the building.

Refer to **Building Envelope** tip sheet available at http://eco3.org/?file_id=19 to learn more about envelope.

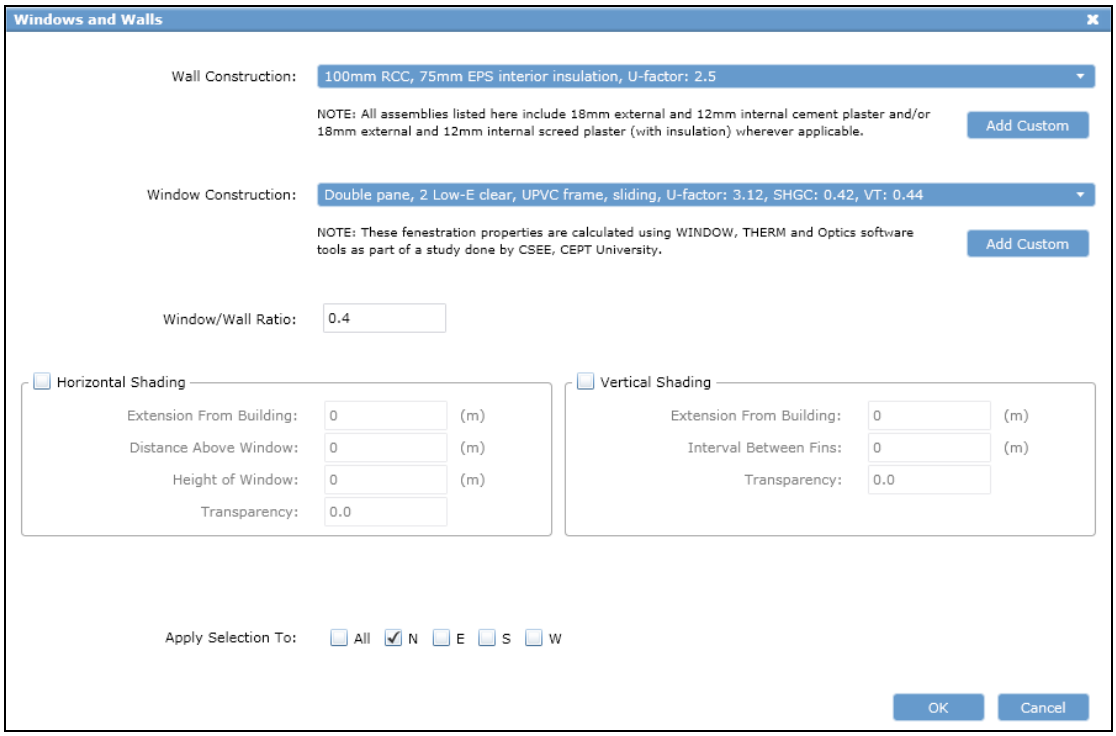
Click **Envelope** tab to define the windows, walls, roofs, and skylights of a building. The tab comprises of two vertical sub-tabs that are explained in the following sub-sections.

8.1. Windows and Walls

This sub-tab is used to define the construction and Window Wall Ratio (WRR), and vertical and horizontal shading.



Click **Edit** above a direction (north, east, south, or west) to edit the details of windows and walls for that direction. The **Windows and Walls** dialog box appears with the default values.

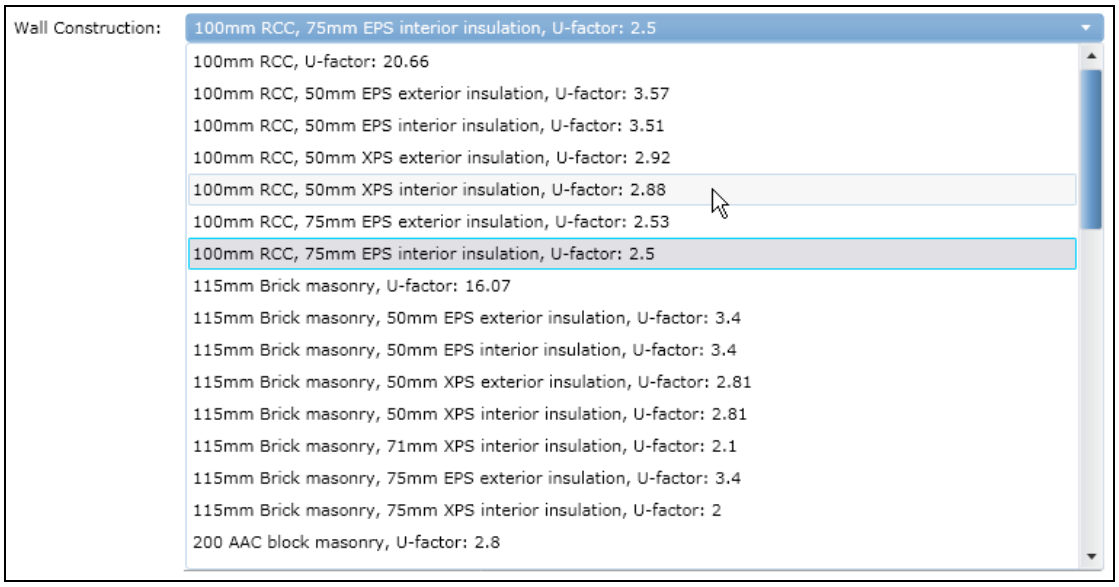


The changes made for a direction (for example, north) can be replicated for other direction(s) (east, south, west) by selecting the relevant check boxes at the bottom of the **Walls and Windows** dialog box.

The following sub-sections explain how to edit the details.

8.1.1. Wall Construction

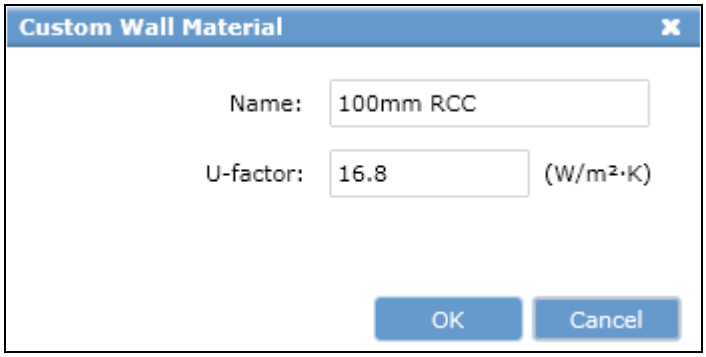
To change **Wall Construction**, click to view the drop-down list of wall assemblies.


Wall Construction:
100mm RCC, 75mm EPS interior insulation, U-factor: 2.5
100mm RCC, U-factor: 20.66
100mm RCC, 50mm EPS exterior insulation, U-factor: 3.57
100mm RCC, 50mm EPS interior insulation, U-factor: 3.51
100mm RCC, 50mm XPS exterior insulation, U-factor: 2.92
100mm RCC, 50mm XPS interior insulation, U-factor: 2.88
100mm RCC, 75mm EPS exterior insulation, U-factor: 2.53
100mm RCC, 75mm EPS interior insulation, U-factor: 2.5
115mm Brick masonry, U-factor: 16.07
115mm Brick masonry, 50mm EPS exterior insulation, U-factor: 3.4
115mm Brick masonry, 50mm EPS interior insulation, U-factor: 3.4
115mm Brick masonry, 50mm XPS exterior insulation, U-factor: 2.81
115mm Brick masonry, 50mm XPS interior insulation, U-factor: 2.81
115mm Brick masonry, 71mm XPS interior insulation, U-factor: 2.1
115mm Brick masonry, 75mm EPS exterior insulation, U-factor: 3.4
115mm Brick masonry, 75mm XPS interior insulation, U-factor: 2
200 AAC block masonry, U-factor: 2.8

- Select the desired assembly.
- If required, make other changes on the **Walls and Windows** dialog box.
- Finally, click **OK**.

Customized Wall Assembly

To add a customized assembly, click **Add Custom**. The **Custom Wall Material** dialog box appears.



- Enter the name of the customized assembly.
- Enter the corresponding U-factor.

  Tip This is an assembly U-factor that includes the effect of air-film on both sides of the wall; this value is not always calculated as the sum of the thermal resistance properties of the wall layers. If required, consult the insulation or

building material manufacturer and ask for a calculation of the assembly U-factor.

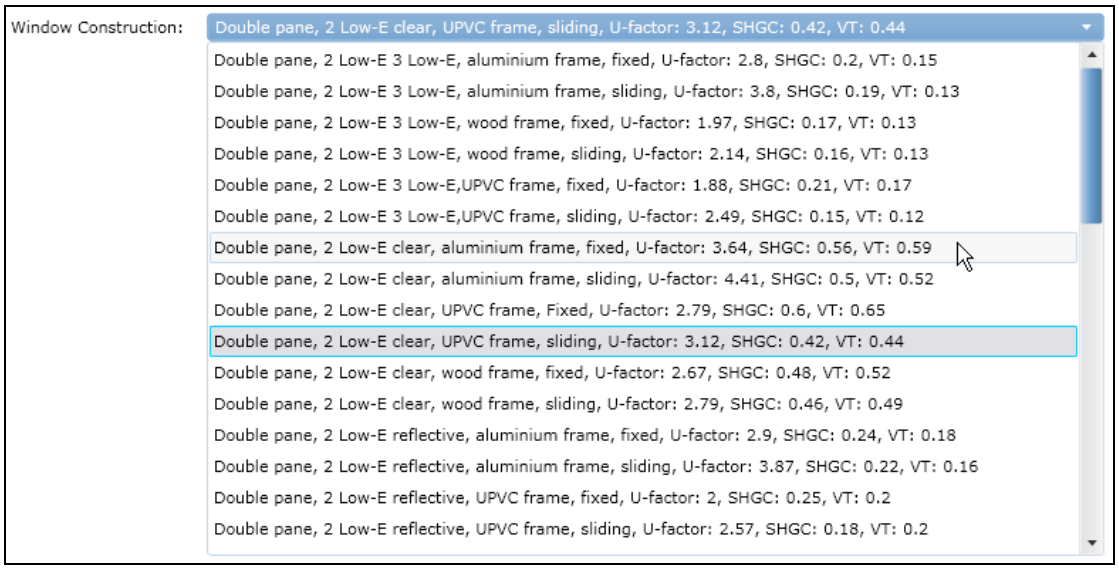
- Click **OK**.

The customized assembly gets listed in the drop-down list with the word '**Custom**' prefixed to it.

- If required, make other changes on the **Walls and Windows** dialog box.
- Finally, click **OK**.

8.1.2. Window Construction

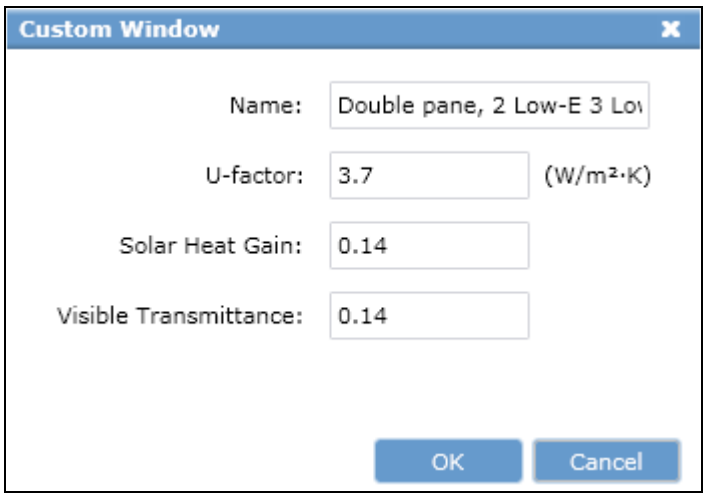
To change **Window Construction**, click to view the drop-down list of window assemblies.


Window Construction:
Double pane, 2 Low-E clear, UPVC frame, sliding, U-factor: 3.12, SHGC: 0.42, VT: 0.44
Double pane, 2 Low-E 3 Low-E, aluminium frame, fixed, U-factor: 2.8, SHGC: 0.2, VT: 0.15
Double pane, 2 Low-E 3 Low-E, aluminium frame, sliding, U-factor: 3.8, SHGC: 0.19, VT: 0.13
Double pane, 2 Low-E 3 Low-E, wood frame, fixed, U-factor: 1.97, SHGC: 0.17, VT: 0.13
Double pane, 2 Low-E 3 Low-E, wood frame, sliding, U-factor: 2.14, SHGC: 0.16, VT: 0.13
Double pane, 2 Low-E 3 Low-E,UPVC frame, fixed, U-factor: 1.88, SHGC: 0.21, VT: 0.17
Double pane, 2 Low-E 3 Low-E,UPVC frame, sliding, U-factor: 2.49, SHGC: 0.15, VT: 0.12
Double pane, 2 Low-E clear, aluminium frame, fixed, U-factor: 3.64, SHGC: 0.56, VT: 0.59
Double pane, 2 Low-E clear, aluminium frame, sliding, U-factor: 4.41, SHGC: 0.5, VT: 0.52
Double pane, 2 Low-E clear, UPVC frame, Fixed, U-factor: 2.79, SHGC: 0.6, VT: 0.65
Double pane, 2 Low-E clear, UPVC frame, sliding, U-factor: 3.12, SHGC: 0.42, VT: 0.44
Double pane, 2 Low-E clear, wood frame, fixed, U-factor: 2.67, SHGC: 0.48, VT: 0.52
Double pane, 2 Low-E clear, wood frame, sliding, U-factor: 2.79, SHGC: 0.46, VT: 0.49
Double pane, 2 Low-E reflective, aluminium frame, fixed, U-factor: 2.9, SHGC: 0.24, VT: 0.18
Double pane, 2 Low-E reflective, aluminium frame, sliding, U-factor: 3.87, SHGC: 0.22, VT: 0.16
Double pane, 2 Low-E reflective, UPVC frame, fixed, U-factor: 2, SHGC: 0.25, VT: 0.2
Double pane, 2 Low-E reflective, UPVC frame, sliding, U-factor: 2.57, SHGC: 0.18, VT: 0.2

- Select the desired assembly.
- If required, make other changes on the **Walls and Windows** dialog box.
- Finally, click **OK**.

Customized Window Assembly

To add a customized assembly, click **Add Custom**. The **Custom Window** dialog box appears.



- Enter the name of the customized assembly.
- Enter the corresponding glazing assembly U-factor.

  This is not the centre of glass U-factor that is listed in the glass manufacturer's catalogue. To get the U-factor of the overall fenestration product, contact the glass manufacturer and ask for it based on the average size of the window units.
- Enter solar heat gain coefficient.
- Enter visible light transmittance.
- Click **OK**.

The customized assembly gets listed in the drop-down list with the word '**Custom**' prefixed to it.

- If required, make other changes on the **Walls and Windows** dialog box.
- Finally, click **OK**.

8.1.3. Window Wall Ratio

This is the ratio of the vertical fenestration (window) area to gross exterior wall area. The gross exterior wall area is measured horizontally from the exterior surface; it is measured vertically from the top of the floor to the bottom of the roof.

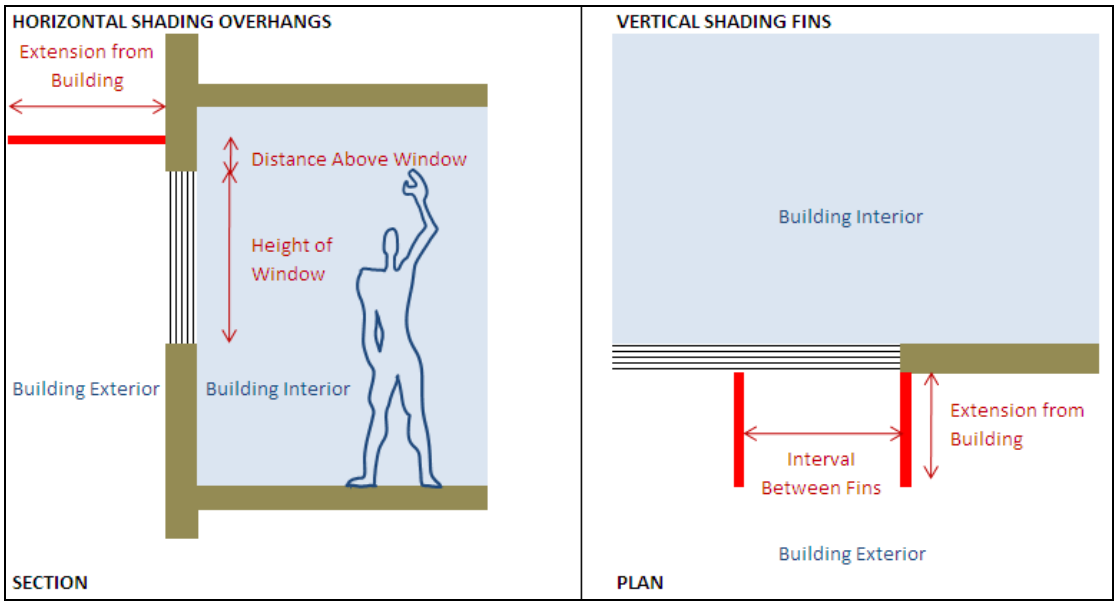
The HVAC engineer for the building is likely to have this information.

On the **Walls and Windows** dialog box:

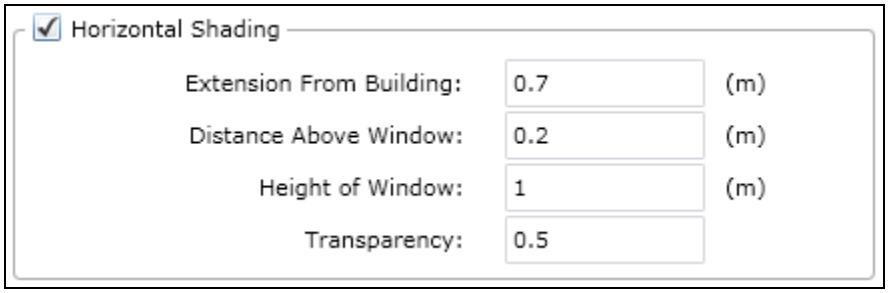
- Enter Window Wall Ratio.
- If required, make other changes on the dialog box.
- Finally, click **OK**.

8.1.4. Shading

The overhangs on a building can reduce solar gains. The inputs for both horizontal shading devices and vertical fins that extend out of a building can be provided in the tool.

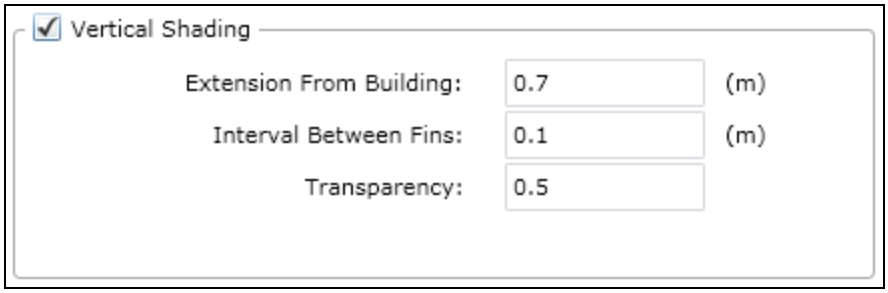


Horizontal Shading



- Select **Horizontal Shading** check box to enter its details.
  See the illustration above to understand the input fields.
- Enter the following details:
  - The extension (in meters) of the overhang from the building.
  - The distance (in meters) of the overhang from the window.
  - The height (in meters) of the windows.
  - The transparency of the horizontal shading.
- If required, make other changes on the **Walls and Windows** dialog box.
- Finally, click **OK**.

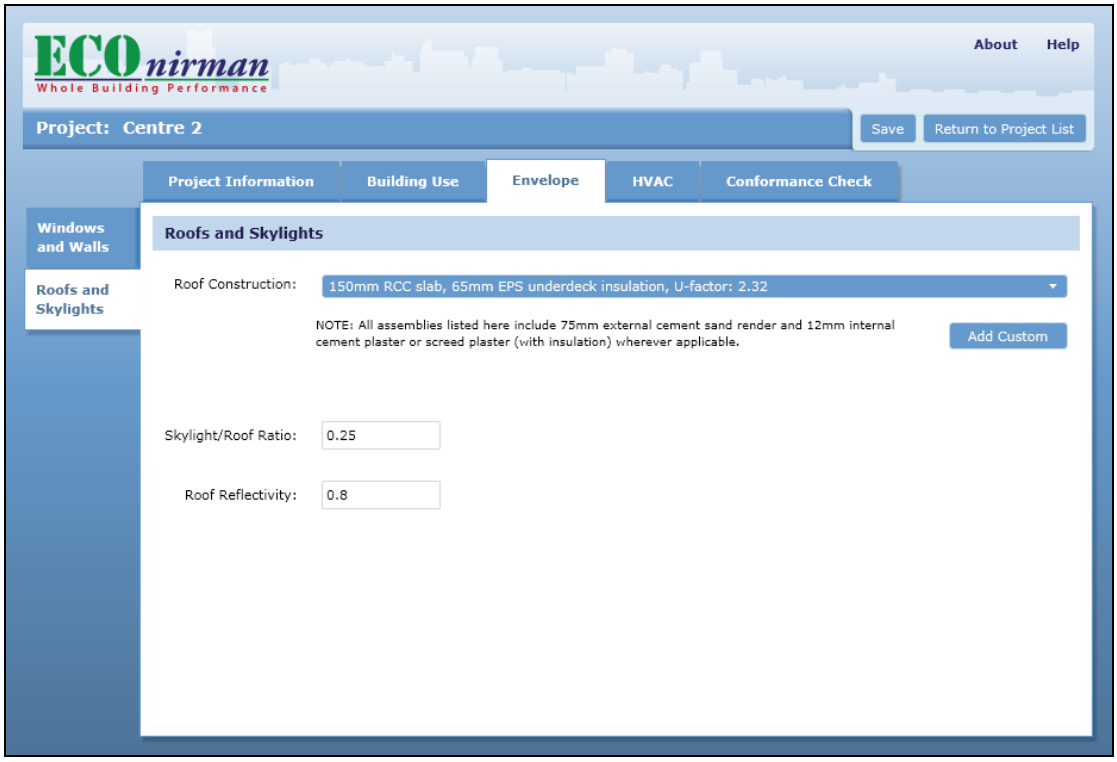
Vertical Shading



- Select **Vertical Shading** check box to enter its details.
  See the illustration above to understand the input fields.
- Enter the following details:
  - The extension (in meters) of the overhang from the building.
  - The interval (in meters) between the fins.
  - The transparency of the vertical shading.
- If required, make other changes on the **Walls and Windows** dialog box.
- Finally, click **OK**.

8.2. Roofs and Skylights

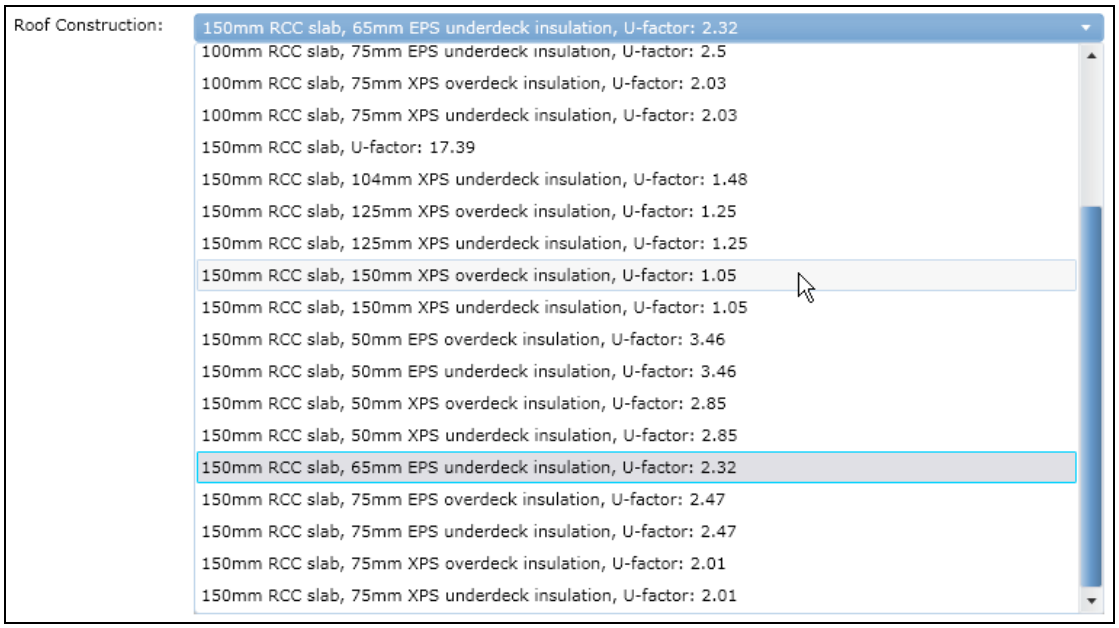
This sub-tab is used to define the construction of building roofs, the skylight roof ratio (SRR), and the roof reflectivity.



The following sub-sections explain how to edit the details.

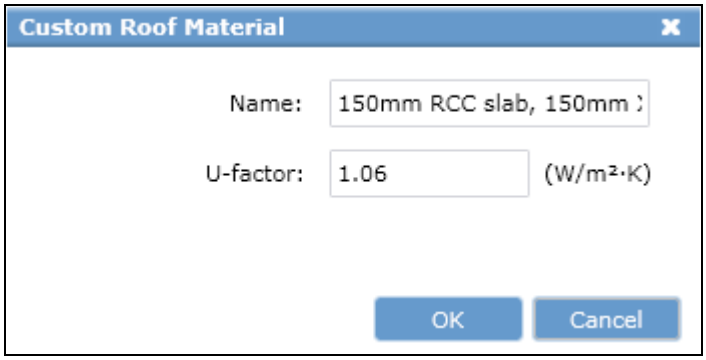
8.2.1. Roof Construction

To change **Roof Construction**, click ▼ to view the drop-down list of roof assemblies to select the desired one.


Roof Construction:
150mm RCC slab, 65mm EPS underdeck insulation, U-factor: 2.32
100mm RCC slab, 75mm EPS underdeck insulation, U-factor: 2.5
100mm RCC slab, 75mm XPS overdeck insulation, U-factor: 2.03
100mm RCC slab, 75mm XPS underdeck insulation, U-factor: 2.03
150mm RCC slab, U-factor: 17.39
150mm RCC slab, 104mm XPS underdeck insulation, U-factor: 1.48
150mm RCC slab, 125mm XPS overdeck insulation, U-factor: 1.25
150mm RCC slab, 125mm XPS underdeck insulation, U-factor: 1.25
150mm RCC slab, 150mm XPS overdeck insulation, U-factor: 1.05
150mm RCC slab, 150mm XPS underdeck insulation, U-factor: 1.05
150mm RCC slab, 50mm EPS overdeck insulation, U-factor: 3.46
150mm RCC slab, 50mm EPS underdeck insulation, U-factor: 3.46
150mm RCC slab, 50mm XPS overdeck insulation, U-factor: 2.85
150mm RCC slab, 50mm XPS underdeck insulation, U-factor: 2.85
150mm RCC slab, 65mm EPS underdeck insulation, U-factor: 2.32
150mm RCC slab, 75mm EPS overdeck insulation, U-factor: 2.47
150mm RCC slab, 75mm EPS underdeck insulation, U-factor: 2.47
150mm RCC slab, 75mm XPS overdeck insulation, U-factor: 2.01
150mm RCC slab, 75mm XPS underdeck insulation, U-factor: 2.01

Customized Roof Assembly

To add a customized assembly, click **Add Custom**. The **Custom Roof Material** dialog box appears.



- Enter the name of the customized assembly.
- Enter the corresponding U-factor.

  This is an assembly U-factor that includes the effect of air-film on both sides of the wall; this value is not always calculated as the sum of the thermal resistance properties of the wall layers. If required, consult the insulation or building material manufacturer and ask for a calculation of the assembly U-factor.
- Click **OK**.

The customized assembly gets listed in the drop-down list with the word '**Custom**' prefixed to it.

8.2.2. Skylight Roof Ratio

It is the ratio of the total skylight area of the roof, measured to the outside of the frame, to the gross exterior roof.

Enter **Skylight/Roof Ratio**.

8.2.3. Roof Reflectivity

As per the ECBC, for the *Standard Design*, exterior roof surfaces, other than those with ventilated attics, must be modelled assuming a surface reflectance value of 0.30. If a *Proposed Design* calls for a reflective roof surface, however, the model may assume a long-term average reflectance of 0.45, which results in the lower heat absorption of the reflective surface and makes a conservative allowance for degradation of the reflectivity over its lifetime. For this exception to be allowed the specified reflectance of the roof in the *Proposed Design* must exceed 0.70 and its emittance must exceed 0.75.

Enter **Roof Reflectivity**.

9. Heating, Ventilation and Air Conditioning

Heating, Ventilation and Air Conditioning (HVAC) refers to the equipment, distribution systems, and terminal units that provide, either collectively or individually, the heating, ventilation, or air-conditioning requirement to a building or a portion of it. HVAC systems account for a significant portion of a commercial building's energy use. HVAC energy use in a commercial building can increase or decrease significantly depending on how efficiently the combination of air side systems and central plant operates. Proven technologies and design concepts can be used to build energy efficiencies in the system and generate significant energy and cost savings.

The best HVAC design considers all the interrelated building systems while addressing indoor air quality, thermal comfort, energy consumption, and environmental benefits.

HVAC systems broadly comprise of **Air Systems**, **Cooling Plant**, and **Heating Plant**.

The following is the list of HVAC systems and what they represent:

Name	Characteristics
Central Plant VAV	Central Variable Air Volume (VAV) AHU with cold and hot water loops from a central chiller and a boiler plant
Central Plant Constant Volume	Central constant volume reheat AHU with cold and hot water loops from a central chiller and boiler plant
Packaged VAV	Packaged VAV system with direct-extension (DX) coil
Packaged Rooftop CAV†	Packaged constant volume system with DX coil
Split system	Split systems, high wall or cassette type
Through-wall system	Mounted through the wall, typically in hotels
Window unit	Unitary window mounted units

† This is a single zone system, where each thermal zone will be assigned a separate system.

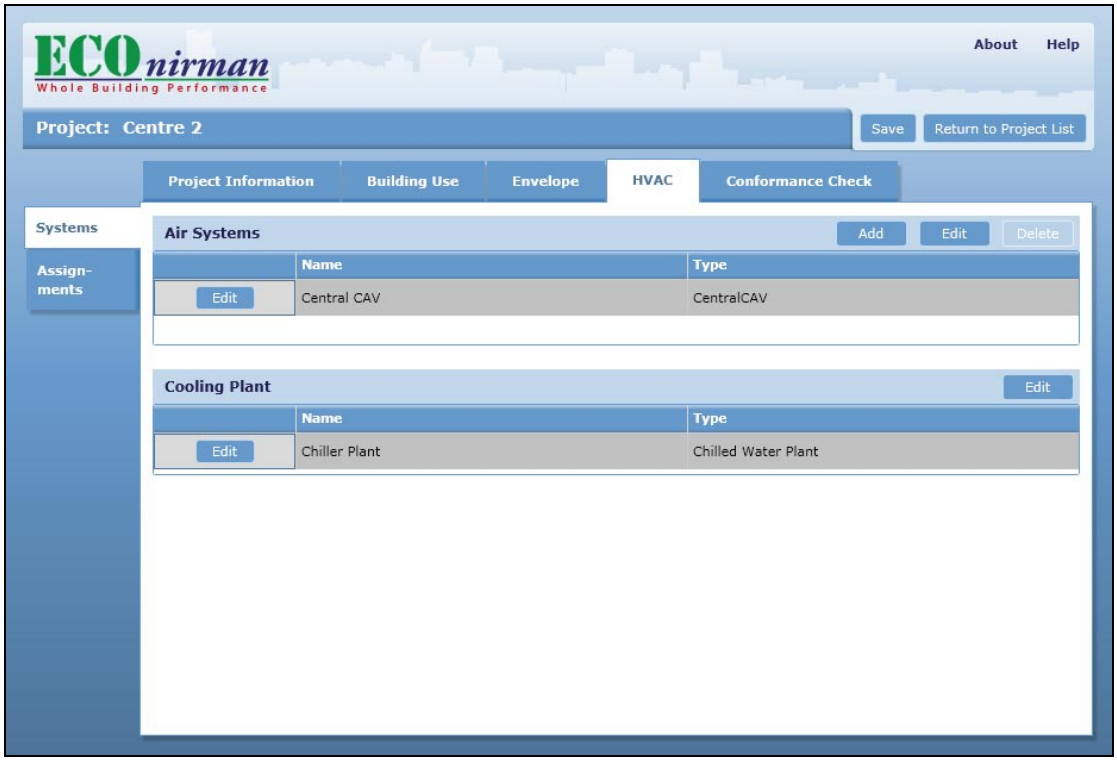
Refer to **HVAC System** tip sheet available at http://eco3.org/?file_id=25 to learn more about HVAC.

Click the **HVAC** tab to define HVAC systems and verify their assignments. The tab comprises of two vertical sub-tabs that are explained in the following sub-sections.

Certain input fields get customized across the tool according to the details entered under these sub-tabs.

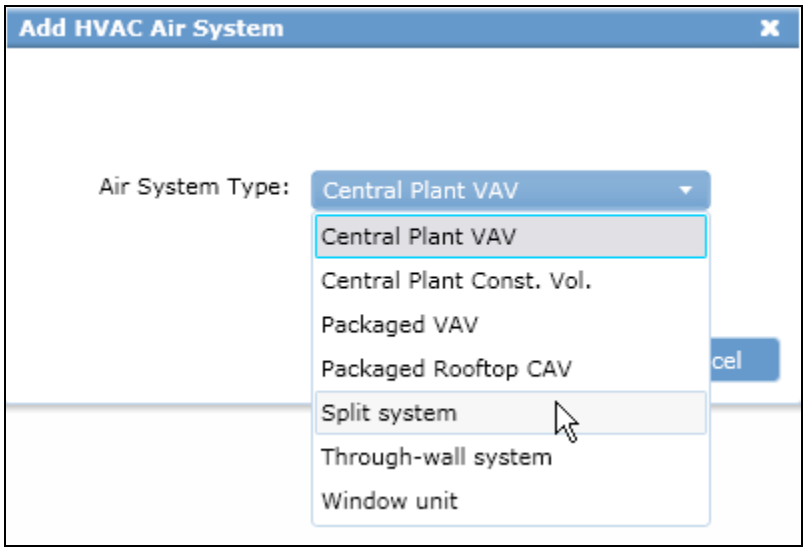
9.1. Systems

This sub-tab is used to add new HVAC systems and edit them. The default system that appears is the system that will be modelled in the *Standard Design*. If this is the system in the *Proposed Design*, then edit its inputs. To change the systems to match the *Proposed Design*, add more systems (§ 9.1.1) to match those in the building and delete the default system shown by the tool (§ 9.1.3).



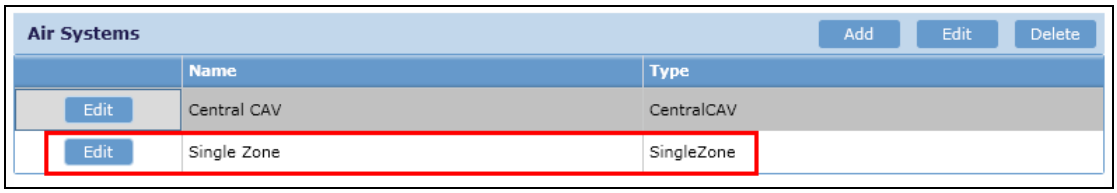
9.1.1. Add System

Click **Add** to add a new system. The **Add HVAC Air System** dialog box appears.



- Select the system from **Air System Type** drop-down menu.
- Click **OK**.

The system gets listed under **Air Systems**.

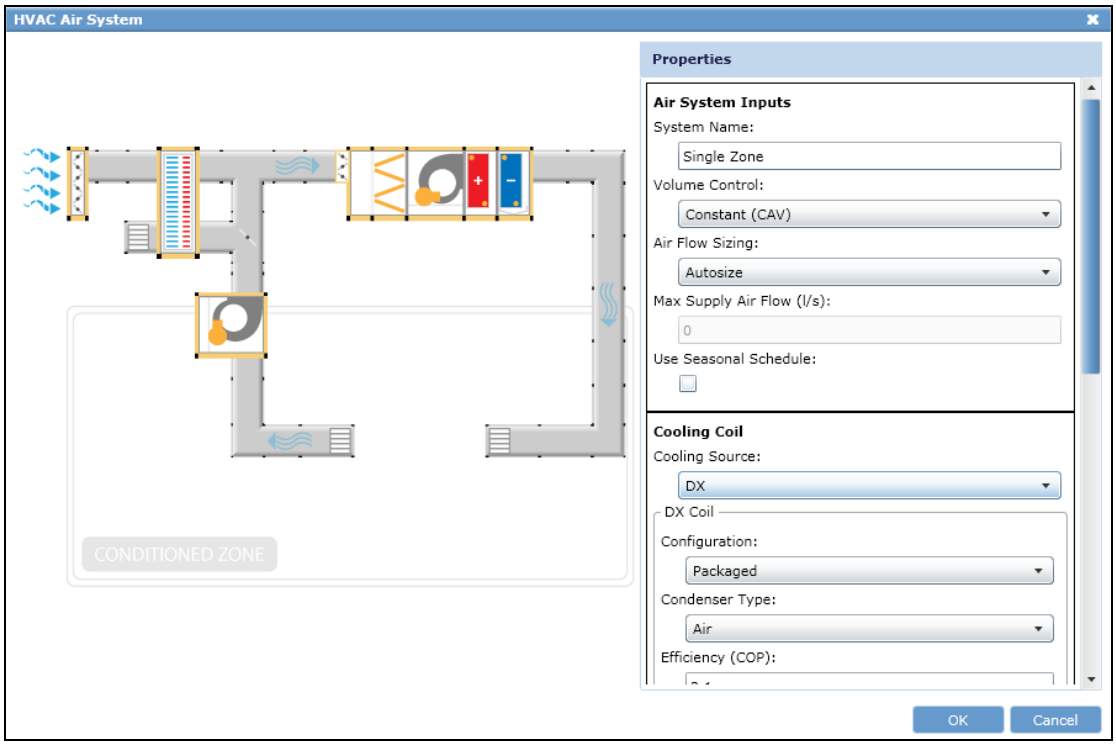


Cooling Plant and/or **Heating Plant** are added by the tool automatically if a system with a plant is specified.

9.1.2. Edit System

To edit a system, click **Edit** adjacent its name. The diagram of the system and its properties appear.

Air Systems



Specify the following properties (customizable inputs):

Properties (Custom Inputs)	**Air System Type**						
	Central Plant VAV	Central Plant Constant Volume	Packaged VAV	Packaged Rooftop CAV	Split System	Through-wall System	Window Unit
Air System Inputs							
System Name	✓	✓	✓	✓	✓	✓	✓
Air Flow Sizing	✓	✓	✓	✓	✓	✓	✓
Maximum Supply Air Flow (l/s)	✓	✓	✓	✓	✓	✓	✓
Use	✓	✓	✓	✓	✓	✓	✓

Properties (Custom Inputs)	Air System Type						
	Central Plant VAV	Central Plant Constant Volume	Packaged VAV	Packaged Rooftop CAV	Split System	Through-wall System	Window Unit
Seasonal Schedule							
Cooling Coil							
Cooling Source	✓	✓	✓	✓	✓	✓	✓
Heating Coil							
Heating Source	✓	✓	✓	✓	✓	✓	✓
Supply Fan							
Location	✓	✓	✓	✓	✓	×	×
Static Pressure (Pa)	✓	✓	✓	✓	✓	×	×
Return Fan							
Static Pressure (Pa)	✓	✓	✓	✓	✓	×	×
Outside Air Control							
Economiz-ing	✓	✓	✓	✓	✓	×	×
Exhaust Air Heat Recovery							
Type	✓	✓	✓	✓	✓	×	×
Terminal Units							
Includes Reheat Coil	✓	✓	✓	✓	✓	×	×
Source	✓	✓	✓	✓	✓	×	×

After entering the details, click **OK** to define the air system.

Cooling and Heating Availability Schedules: The tool gives an option to select seasonal availability of heating and cooling for each individual HVAC system included in the building. If the seasonal availability is not selected by the user, the tool allows heating and cooling to be available through the entire year. Select the seasonal option if heating is to be turned off in the non-winter months in a cold

climate, or if cooling is to be turned off in temperate or cool months. This will ensure EPI predictions that are not unrealistically high. This schedule is identical for the *Standard Design* and the *Proposed Building* models. The tool arrives at the season schedule using the following algorithm:

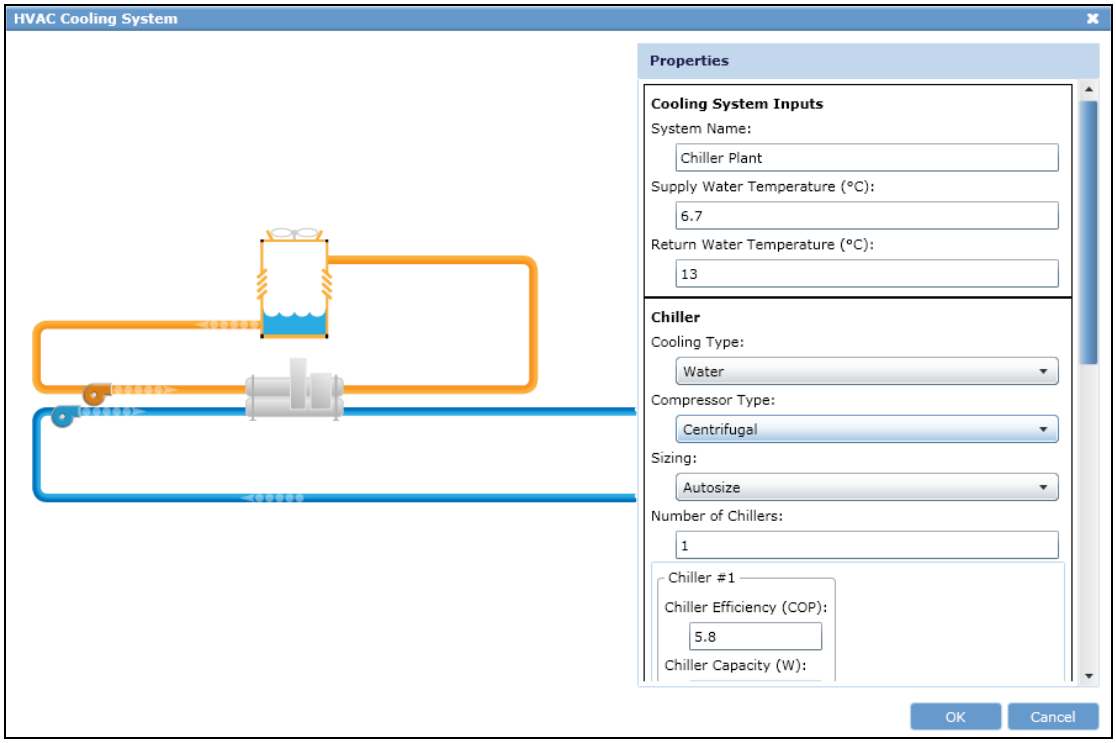
- If the monthly average **dry-bulb temperature** is more than 26°C AND monthly average **enthalpy** is more than 60 kJ/kg, then cooling will be available. It will not be available otherwise.

- If the monthly average **dry-bulb temperature** is less than 15°C, heating will be available. It will not be available otherwise.
  Heating availability is not dependent on enthalpy.

The above algorithm results in operating the systems for heating and cooling when the monthly average values fall outside the comfort range according to ISO 7730-1993. In some places like Mumbai, this algorithm will result in no difference between a seasonal availability and year-round availability, as the thresholds for turning off cooling or turning on heating will never be crossed.

Cooling Plant and/or **Heating Plant** are added depending on how an air system is configured.

Cooling Plant

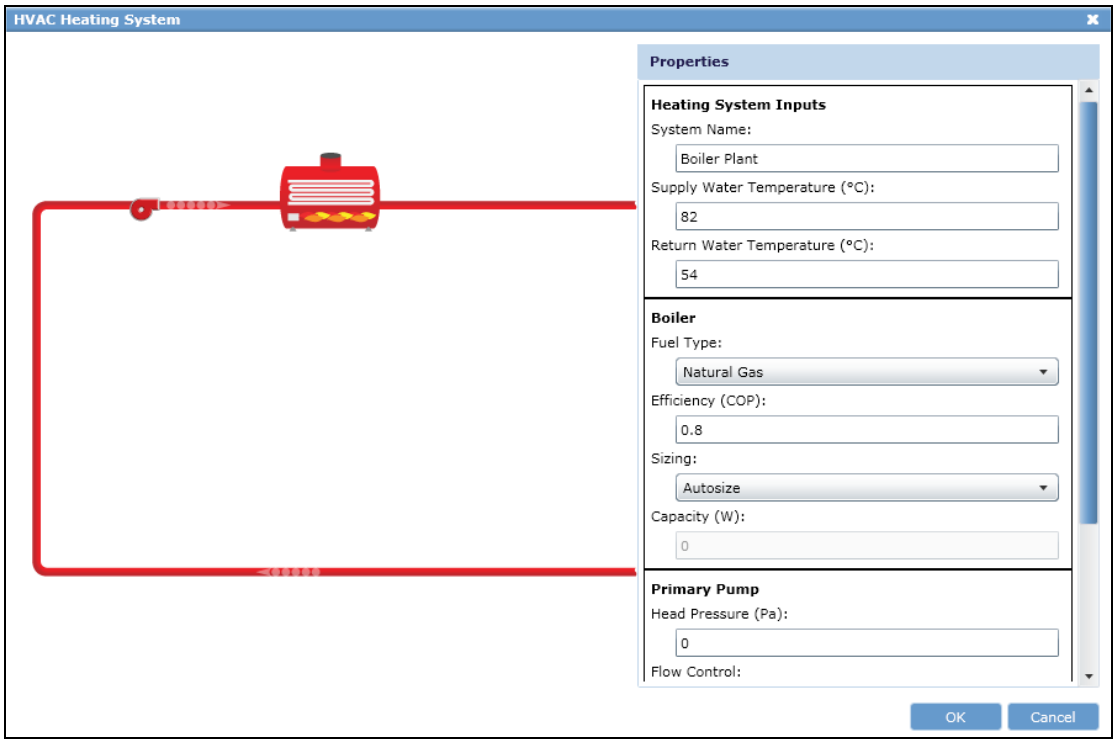


Specify the following properties (customizable inputs):

- Cooling System Inputs
- Chiller(s)
- Cooling Tower
- Primary Pump
- Secondary Pump
- Condenser Pump

Finally, click **OK** to define the cooling plant.

Heating Plant



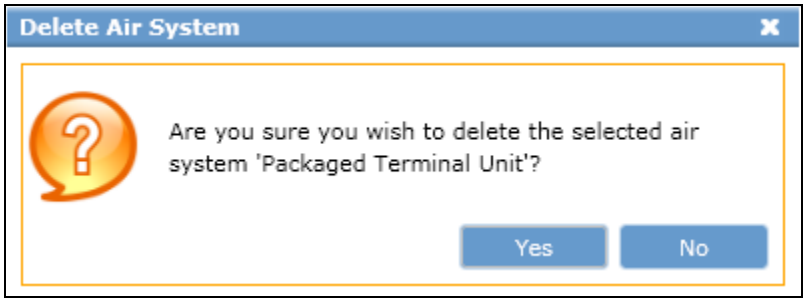
Specify the following properties (customizable inputs):

- Heating System Inputs
- Boiler
- Primary Pump
- Secondary Pump

Finally, click **OK** to define the heating plant.

9.1.3. Delete System

To delete a system, select it and click **Delete**. A confirmation dialog box appears.



Click **Yes** to delete the system. The system gets delisted.

There is no way to undo this action and retrieve a deleted system.

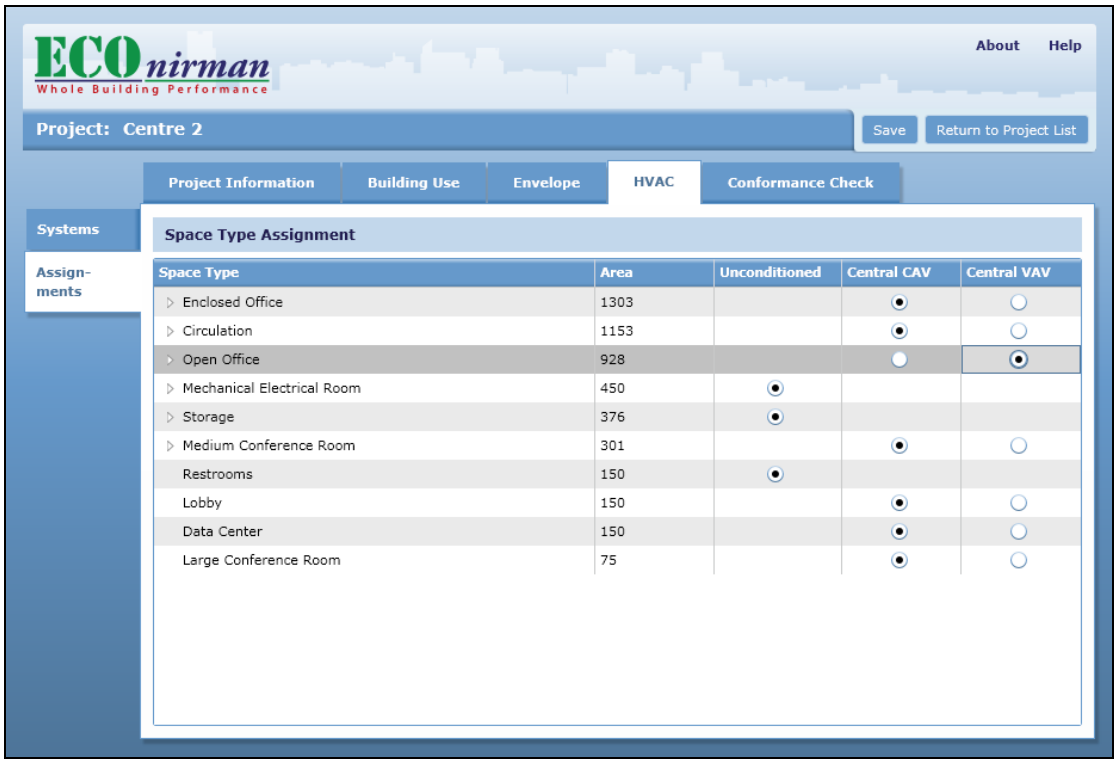
9.2. Assignments

As per the ECBC, HVAC Zone is a space or group of spaces within a building with heating and cooling requirements that are sufficiently similar so that the desired conditions (for example, temperature) can be maintained throughout using a single sensor (such as thermostat or temperature sensor).

A zone represents area catered to by one air conditioning unit. With the help of zoning, building plans are simplified to reduce the modeller's work. Normally, usage pattern, set point temperature, and other conditions are identical within one zone. The building spaces that would experience similar heating and cooling loads are generally grouped under one zone.

ECOnirman WBP Tool lists all the resulting zone types for each space type and allows assigning different HVAC systems to them individually or as a group for an entire space type. This allows the user to appropriately assign a different HVAC system for the perimeter zones versus the core zones, and different HVAC systems to different perimeter zones.

This sub-tab is used to verify and/or assign the HVAC systems to different space types or zones.



Assign the system to the space type by selecting the corresponding radio button. A combination of perimeter (by orientation) and core zones are created by the tool depending on the user inputs under the Zoning sub-tab (§ 7.2).

Tip Click ▷ adjacent to a space type to expand or collapse the tree structure in order to make HVAC system assignments at a detailed level by perimeter and orientation.

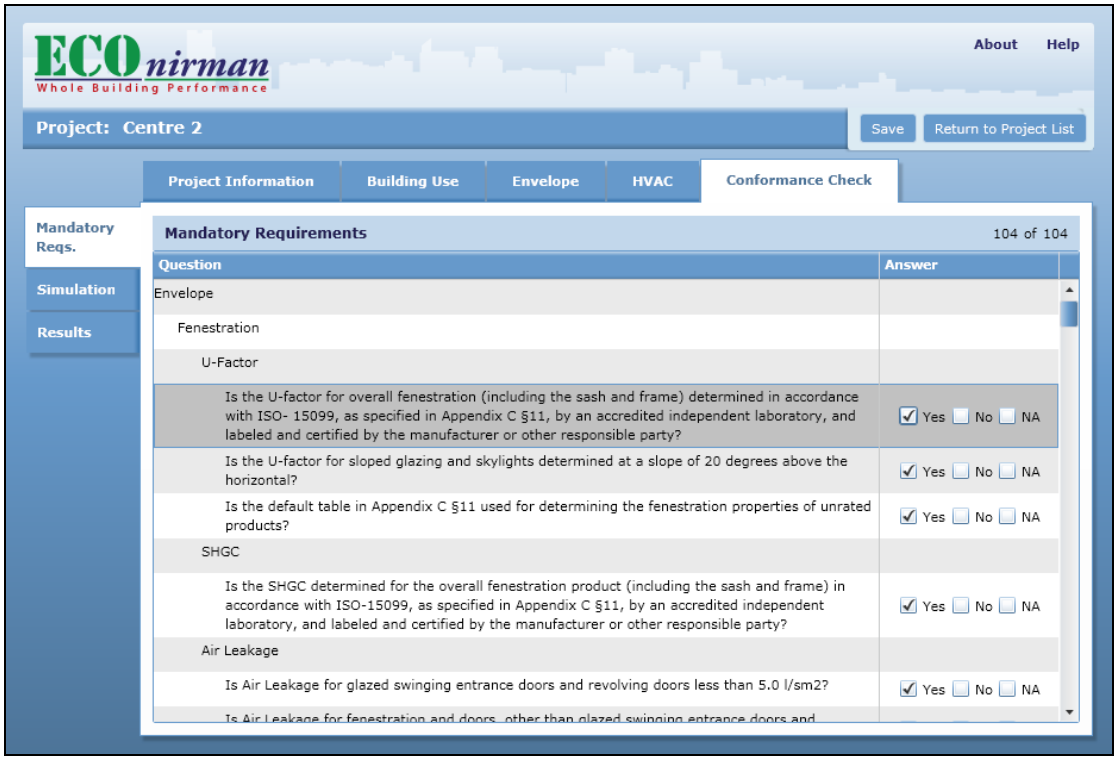
10. Conformance Check

ECOnirman WBP Tool provides the conformance assessment result with a detailed report. This report can be used to as documentation for submitting to the *Authority Having Jurisdiction*. The information in the report can also be used for analysis and subsequent improvement of the building performance.

Click the **Conformance Check** tab to respond to the mandatory requirements of the ECBC, run the simulation, and view the conformance results. The tab comprises of three vertical sub-tabs that are explained in the following sub-sections.

10.1. Mandatory Requirements

This sub-tab is used answer the questions related to the mandatory requirements of the ECBC to assess conformance of the building.

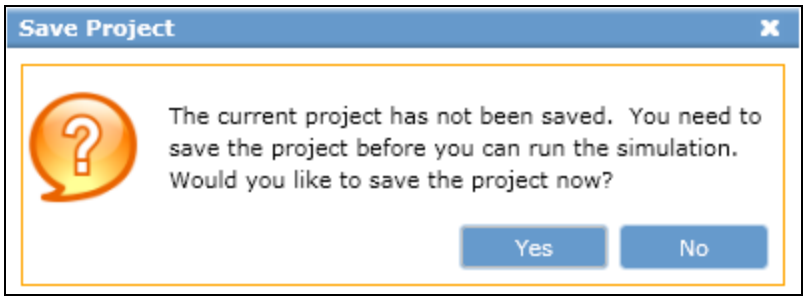

ECOnirman
Whole Building Performance
About
Help
Project: Centre 2
Save
Return to Project List
Project Information
Building Use
Envelope
HVAC
Conformance Check
Mandatory Reqs.
Simulation
Results
Mandatory Requirements
104 of 104
Question
Answer
Envelope
Fenestration
U-Factor
Is the U-factor for overall fenestration (including the sash and frame) determined in accordance with ISO- 15099, as specified in Appendix C §11, by an accredited independent laboratory, and labeled and certified by the manufacturer or other responsible party?
Yes No NA
Is the U-factor for sloped glazing and skylights determined at a slope of 20 degrees above the horizontal?
Yes No NA
Is the default table in Appendix C §11 used for determining the fenestration properties of unrated products?
Yes No NA
SHGC
Is the SHGC determined for the overall fenestration product (including the sash and frame) in accordance with ISO-15099, as specified in Appendix C §11, by an accredited independent laboratory, and labeled and certified by the manufacturer or other responsible party?
Yes No NA
Air Leakage
Is Air Leakage for glazed swinging entrance doors and revolving doors less than 5.0 l/sm2?
Yes No NA

The responses to **all** the mandatory requirements have to be either **Yes** or not applicable (**NA**) for the building to conform with the ECBC. The building will be non-conformant if the answer to even one mandatory requirement is **No**.

10.2. Simulation

This sub-tab is used to run the simulation for the *Proposed Design* vis-à-vis the *Standard Design* to assess conformance of the building with the ECBC.

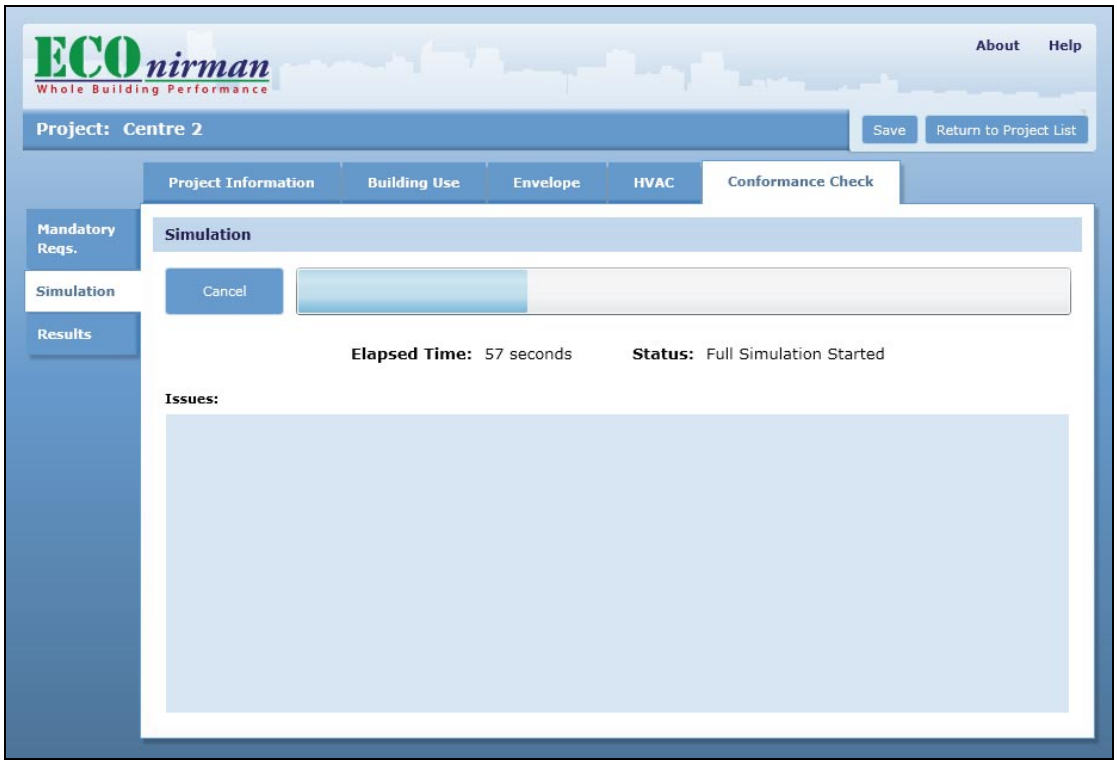
Click **Run** to initiate the simulation. A dialog box appears to save the project if there are unsaved changes before initiating the simulation.


Save Project
The current project has not been saved. You need to save the project before you can run the simulation. Would you like to save the project now?
Yes
No

Click **Yes** to save the project inputs.

It is imperative to save the inputs before running the simulation. Otherwise, any unsaved details under the tabs/sub-tabs will be lost.

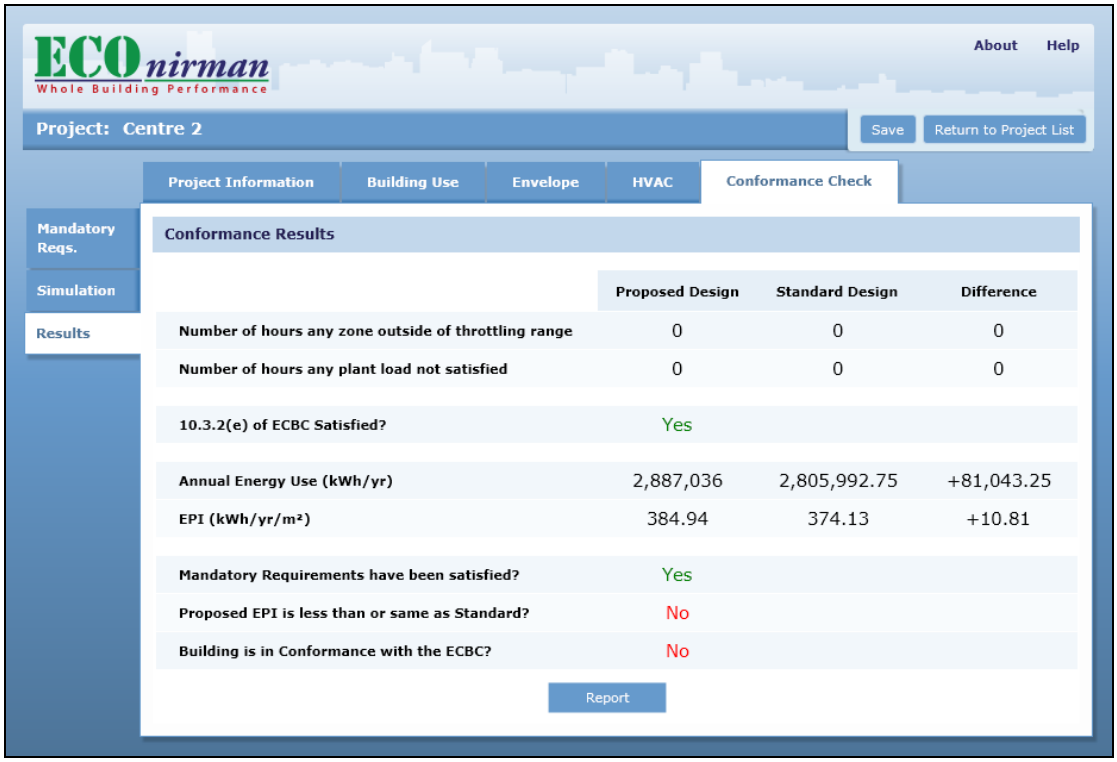
The simulation starts.



The progress bar, time elapsed, status of the simulation, and issues encountered are displayed.

10.3. Results

This sub-tab is used to view the results of the simulation at the end of the run.



10.3.1. Interpreting the Results

Meeting the Loads

Appendix B of the ECBC contains requirements in § 10.3.2 (e) for meeting the building loads through sizing of the systems and plant. The tool displays the results of the simulation vis-à-vis these requirements. The unmet load hours (**number of hours any zone outside of throttling range** and **number of hours any plant load not satisfied**) for the *Proposed Design* must not differ from unmet load hours for the *Standard Design* by more than 50 hours. And the maximum number of unmet hours must not exceed 300 hours for either case. If these conditions are met, then the design satisfies § 10.3.2 (e) of the ECBC. Whereas, if these conditions are not met, then the simulation results may not be submitted to demonstrate conformance; the inputs for sizing of the HVAC systems need to be revised in the tool till § 10.3.2 (e) of the ECBC is satisfied.

Depending on the inputs provided, it is possible in certain cases that the simulation results show that the hours when loads are not met by the HVAC equipment exceed those allowed in Appendix B of the ECBC. This is most likely to happen in the following situation:

A seasonal cooling availability for the building is selected. So depending on the weather file, the tool will turn off cooling for certain months of the year and change the cooling set-points for those months to 50°C.

However, the building may have a data centre with high internal loads. So during those months when cooling is not available, the data centre space may have a number of hours when the space temperature exceeds the cooling set-point. The tool will report those as hours when cooling load is not met. If those hours exceed the limits allowed by Appendix B of the ECBC, the tool will report the building as not conforming because a valid simulation has not been run.

To resolve this problem, make sure that such high load zones needing year-round cooling are on a separate HVAC system and that those systems are not selected for seasonal cooling availability. Then assign those zones or space types to a separate HVAC system under the Assignments sub-tab (§ 9.2). If the building does not have separate systems for such zones, then the simulation needs to run with cooling being always available to the building.

Energy Use and Energy Performance Intensity (EPI)

The energy use and the EPI of the *Proposed Design* must not exceed that of the *Standard Design*. Otherwise, the design will not conform with the ECBC otherwise.

10.3.2. Building Conformance Report

Click **Report** at the bottom right corner of the **Results** sub-tab to generate a detailed Building Conformance Report as a Portable Document Format (PDF) file.

The following is the composition of the building conformance report:

Report Section	Details Captured
Building Summary	Address, type, area, location, climate, ECBC conformance summary
Advisory Messages	Sizing results, errors, warnings
Building Use	Electrical systems and process loads (with schedules) for

Report Section	Details Captured
	different space types
Building Envelope	Building envelope design inputs
HVAC Proposed Design Details	HVAC system inputs
HVAC Assignments	HVAC assignments to different space types
Mandatory Requirements	List of mandatory requirements with responses
Baseline Performance	The *Standard Design* performance
Performance Rating Table	Performance rating of the *Proposed Design* vis-à-vis the *Standard Design*
Energy Consumption	Energy consumed by the *Proposed Design* and the *Standard Design*

11. Appendix A: Definitions and Acronyms

11.1. Definitions

The following are certain relevant definitions from the ECBC 2007.

Boiler: a self-contained low-pressure appliance for supplying steam or hot water.

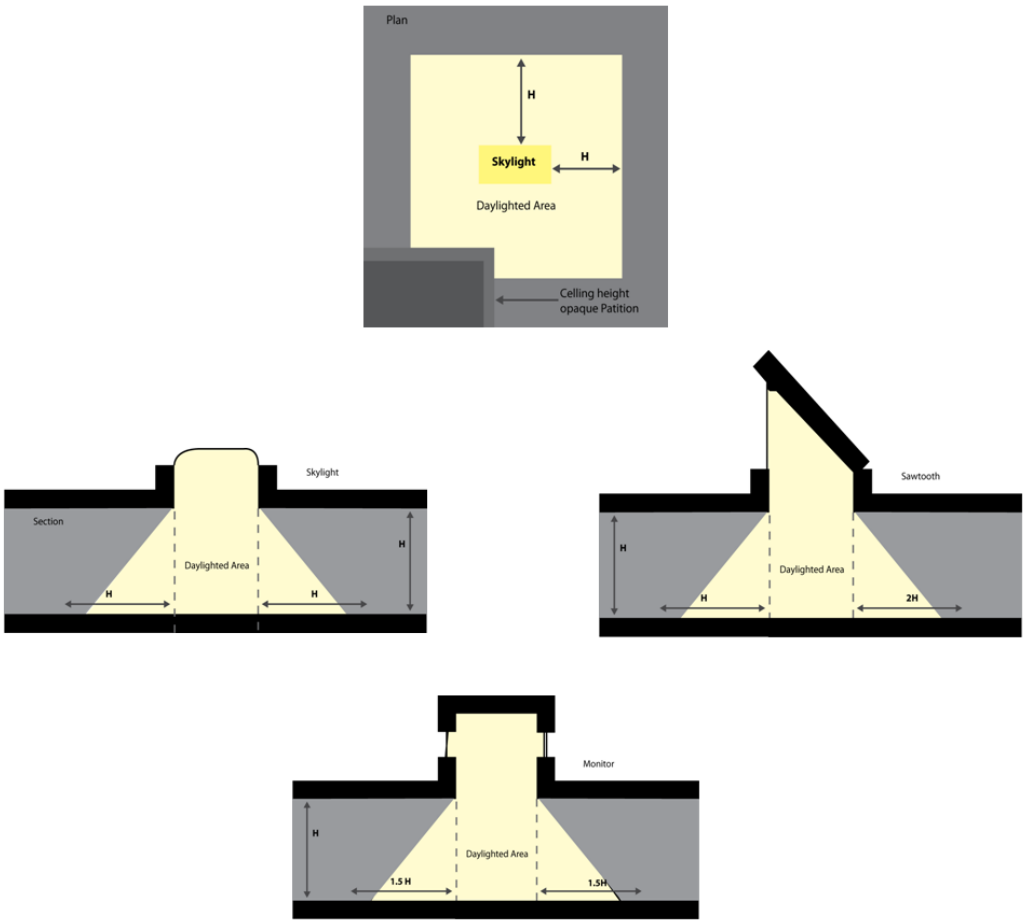
Building envelope: the exterior plus the semi-exterior portions of a building. For the purposes of determining building envelope requirements, the classifications are defined as follows:

Coefficient Of Performance (COP) – cooling: the ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.

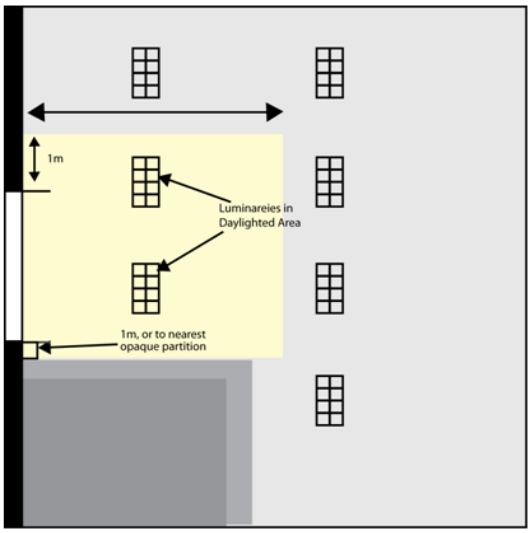
Coefficient Of Performance (COP) – heating: the ratio of the rate of heat delivered to the rate of energy input, in consistent units, for a complete heat pump system, including the compressor and, if applicable, auxiliary heat, under designated operating conditions.

Daylighted area: the daylight illuminated floor area under horizontal fenestration (skylight) or adjacent to vertical fenestration (window), described as follows:

- **Horizontal Fenestration:** the area under a skylight, monitor, or sawtooth configuration with an effective aperture greater than 0.001 (0.1%). The daylighted area is calculated as the horizontal dimension in each direction equal to the top aperture dimension in that direction plus either the floor-to-ceiling height (H) for skylights, or 1.5 H for monitors, or H or 2H for the sawtooth configuration, or the distance to the nearest 1000 mm (42 in) or higher opaque partition, or one-half the distance to an adjacent skylight or vertical glazing, whichever is least, as shown in the plan and section figures below.



- **Vertical Fenestration:** the floor area adjacent to side apertures (vertical fenestration in walls) with an effective aperture greater than 0.06 (6%). The daylighted area extends into the space perpendicular to the side aperture a distance either two times the head height of the side aperture or to the nearest 1.35 m (54 in) or higher opaque partition, whichever is less. In the direction parallel to the window, the daylighted area extends a horizontal dimension equal to the width of the window plus either 1 m (3.3 ft) on each side of the aperture, the distance to an opaque partition, or one-half the distance to an adjacent skylight or window, whichever is least.



Economizer, air: a duct and damper arrangement and automatic control system that together allow a cooling system to supply outdoor air to reduce or eliminate the need for mechanical cooling during mild or cold weather.

Economizer, water: a system by which the supply air of a cooling system is cooled indirectly with water that is itself cooled by heat or mass transfer to the environment without the use of mechanical cooling.

Fenestration: all areas (including the frames) in the building envelope that let in light, including windows, plastic panels, clerestories, skylights, glass doors that are more than one-half glass, and glass block walls.

- **Skylight:** a fenestration surface having a slope of less than 60 degrees from the horizontal plane. Other fenestration, even if mounted on the roof of a building, is considered vertical fenestration.
- **Vertical fenestration:** all fenestration other than skylights. Trombe wall assemblies, where glazing is installed within 300 mm (12 in) of a mass wall, are considered walls, not fenestration.

Fenestration area: total area of the fenestration measured using the rough opening and including the glazing, sash, and frame. For doors where the glazed vision area is less than 50% of the door area, the fenestration area is the glazed vision area. For all other doors, the fenestration area is the door area.

HVAC system: the equipment, distribution systems, and terminals that provide, either collectively or individually, the processes of heating, ventilating, or air conditioned to a building or portion of a building.

Kilovolt-ampere: where the term “kilovolt-ampere” (kVA) is used in this standard, it is the product of the line current (amperes) times the nominal system voltage (kilovolts) times 1.732 for three-phase currents. For single-phase applications, kVA is the product of the line current (amperes) times the nominal system voltage (kilovolts).

Kilowatt: the basic unit of electric power, equal to 1000 W.

Lighted floor area, gross: the gross floor area of lighted spaces.

Lighting Power Density: the maximum lighting power per unit of area of a building classification of space function.

Packaged Terminal Air Conditioner: a factory-selected wall sleeve and separate unencased combination of heating and cooling components, assemblies, or sections. It may include heating capability by hot water, steam, or electricity, and is intended for mounting through the wall to service a single room or zone.

Process load: the load on a building resulting from the consumption or release of process energy.

R-value (thermal resistance): the reciprocal of the time rate of heat flow through a unit area induced by a unit temperature difference between two defined surfaces of material or construction under steady-state conditions. Units of R are m^2-°C/W (h-ft^2-°F/Btu). For the prescriptive building envelope option, R-value is for the insulation alone and does not include building materials or air films.

Roof: the upper portion of the building envelope, including opaque areas and fenestration, that is horizontal or tilted at an angle of less than 60° from horizontal.

Roof area, gross: the area of the roof measured from the exterior faces of walls or from the centerline of party walls.

Single-zone system: an HVAC system serving a single HVAC zone.

Skylight roof ratio (SRR): is the ratio of the total skylight area of the roof, measured to the outside of the frame, to the gross exterior roof.

Solar Heat Gain Coefficient: the ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes

directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space.

Standard Design: A computer representation of a hypothetical design based on the actual proposed design as per Appendix B of the ECBC.

Thermal block: a collection of one or more HVAC zones grouped together for simulation purposes. Spaces need not be contiguous to be combined within a single thermal block.

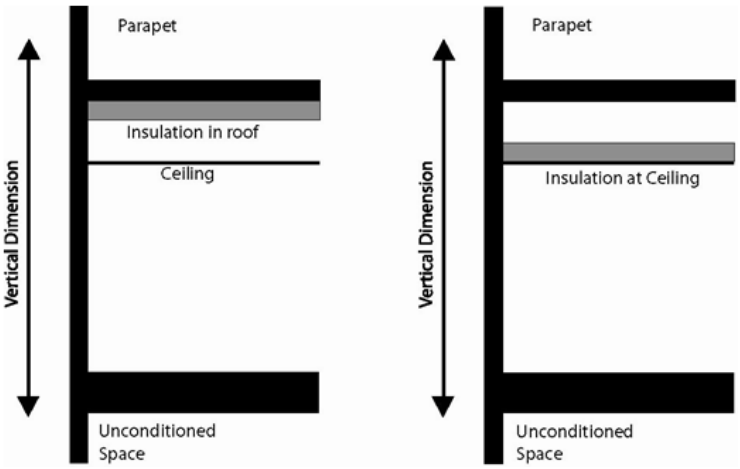
U-factor (Thermal Transmittance): heat transmission in unit time through unit area of a material or construction and the boundary air films, induced by unit temperature difference between the environments on each side. Units of U are W/m^2-^oC (Btu/h-ft^2-°F).

Variable Air Volume system: HVAC system that controls the dry-bulb temperature within a space by varying the volumetric flow of heated or cooled supply air to the space.

Wall: that portion of the building envelope, including opaque area and fenestration, that is vertical or tilted at an angle of 60° from horizontal or greater. This includes above- and below-grade walls, between floor spandrels, peripheral edges of floors, and foundation walls.

- **wall, above grade:** a wall that is not below grade
- **wall, below grade:** that portion of a wall in the building envelope that is entirely below the finish grade and in contact with the ground

Wall area, gross: the overall area off a wall including openings such as windows and doors, measured horizontally from outside surface to outside service and measured vertically from the top of the floor to the top of the roof. If roof insulation is installed at the ceiling level rather than the roof, then the vertical measurement is made to the top of the ceiling. (Note that ECBC § 4.3.1 does not allow roof insulation to be located on a suspended ceiling with removable ceiling panels.) The gross wall area includes the area between the ceiling and the floor for multi-story buildings.



Window Wall Ratio: is the ratio of vertical fenestration area to gross exterior wall area. Gross exterior wall area is measured horizontally from the exterior surface; it is measured vertically from the top of the floor to the bottom of the roof.

Zone, HVAC: A space or group of spaces within a building with heating and cooling requirements that are sufficiently similar so that desired conditions (e.g., temperature) can be maintained throughout using a single sensor (e.g., thermostat or temperature sensor).

11.2. List of Acronyms

The following is the list of relevant acronyms.

AC	Air Conditioner
AFUE	Annual fuel utilization efficiency
AHU	Air Handling Unit
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
Btu	British thermal unit
Btu/ft^2 °F	British thermal units per square foot per degree Fahrenheit
Btu/h	British thermal units per hour
Btu/h ft °F	British thermal units per lineal foot per degree Fahrenheit
Btu/h ft^2	British thermal units per hour per square foot
Btu/h ft^2 °F	British thermal units per hour per square foot per degree Fahrenheit
C	Celsius
CAV	Constant Air Volume
cfm	Cubic feet per minute
cm	Centimeter
COP	Coefficient of Performance
DG/GG	Diesel Generator/Gas Generator
DX	Direct expansion
EC Act 2001	Energy Conservation Act 2001
ECBC	Energy Conservation Building Code
ECM	Energy Conservation Measure
ECO-III	Energy Conservation and Commercialization - Phase III
EER	Energy Efficiency Ratio
EF	Energy Factor
EPI	Energy Performance Intensity
F	Fahrenheit
Ft	Foot
GIS	Geospatial Information System
H	Hour

h ft^2 °F/Btu	Hour per square foot per degree Fahrenheit per British thermal unit
h m^2 °C/W	Hour per square meter per degree Celsius per Watt
HC	Heat capacity
hp	Horsepower
HSD	High Speed Diesel
HSPF	Heating seasonal performance factor
HVAC	Heating, Ventilation and Air Conditioning
in.	Inch
I-P	Inch-pound
IPLV	Integrated part-load value
IRG	International Resources Group
ISHRAE	Indian Society of Heating, Refrigeration and Air-conditioning Engineers
ISO	International Organization for Standardization
kVA	kilovolt-ampere
kW	kilowatt
kWh	kilowatt-hour
LE	Lighting efficacy
Lin	Linear
lin ft	Linear foot
lin m	Linear meter
lm	Lumen
LPD	Lighting Power Density
m	Meter
mm	Millimeter
NAECA	National Appliance Energy Conservation Act
PDF	Portable Document Format
PF	Projection factor
PSZ	Packaged Single Zone
PTAC	Packaged Terminal Air Conditioner
R	R-value (thermal resistance)
RHFS	Reheat Fan System
Rs.	Indian Rupees
SC	Shading Coefficient
SHGC	Solar Heat Gain Coefficient
SHWP	Service Hot Water and Pumping
SL	Standby loss
SRR	Skylight roof ratio
Sq. Meter	Square Meter

TR	Tons of Refrigeration
TWGI	The Weidt Group, Inc.
ULB	Urban Local Body
USAID	United States Agency for International Development
VAV	Variable Air Volume
VLT	Visible Light Transmission
W	Watt
W/ft^2	Watts per square feet
W/m °C	Watts per lineal meter per degree Celsius
W/m^2	Watts per square meter
W/m2 °C	Watts per square meter per degree Celsius
Wh	Watthour
WRR	Window Wall Ratio

12. Appendix B: Sizing Protocol for HVAC Systems

ECOnirman WBP Tool follows the HVAC system sizing protocol of Appendix B.

12.1. System Already Designed

When HVAC system is already designed:

- The equipment size in the *Proposed Design* (AS_{PD}) is provided. This is used in the annual simulation of the *Proposed Design*.
- The tool executes a sizing run for the *Proposed Design* and derives the equipment size (SS_{PD}).
- The ratio of the AS_{PD} to SS_{PD} is the ratio R.
- The tool executes a sizing run for the *Standard Design* and derives the equipment size (SS_{SD}).
- The product of R and SS_{SD} is the size of the equipment (AS_{SD}) to be used in the annual simulation run of the *Standard Design*.

12.2. System Not Yet Designed

When HVAC system has not been designed and the information is not available:

- The equipment size in the *Proposed Design* is not provided. The tool executes a sizing run for the *Proposed Design* and derives the equipment size (SS_{PD}).
- The tool over-sizes the equipment for the annual simulation run of the *Proposed Design* by 15% for cooling and 25% for heating.
- The tool executes a sizing run for the *Standard Design* and derives the equipment size (SS_{SD}).
- The tool over-sizes the equipment for the annual simulation run of the *Standard Design* (AS_{SD}) by 15% for cooling and 25% for heating.

13. Appendix C: Computer Settings

ECOnirman WBP Tool is a web based rich Internet application (RIA) that has many of the characteristics of desktop application software. It runs on a standard web browser and communicates with a web service, where the building model is built in the cloud (Internet). The energy simulation also runs in the cloud using the DOE2.1E engine. As a result, simulation or any other special software need not be installed on the computer. Additionally, the following are updated automatically:

- Tool features
- Default inputs in the tool
- Energy modelling protocols
- The ECBC revisions impacting the simulation

The tool runs faster without using much connectivity bandwidth as a result of minimal data exchange with the servers (as in the case of traditional applications).

The following are the system settings and recommendations to use ECOnirman WBP Tool:

- Microsoft® Silverlight™ should be installed on the computer to use the tool.

  Silverlight™ can be downloaded free of cost from www.silverlight.net (consult the System Administrator for assistance, if required).
- No other plug-in or simulation software is required to use the tool.
- The tool is best viewed in 1024x768 or higher screen resolution.
- For security reasons, logout of the tool after each session.

13.1. Web Browser

- ECOnirman WBP Tool works with all the popular web browsers. It is recommended to use the latest versions of the web browsers available in the market for an optimal experience.
- It takes some time for the tool to load in the web browser for the first time. The loading time reduces subsequently.
- JavaScript must be enabled in the web browser.
- The web browser must be set to accept cookies.
- If the web browser has a provision, add http://econirmanwbp.eetools.in as a trusted site.

13.2. Conformance Reports

- All conformance reports are generated as Portable Document Format (PDF) files. Therefore, Adobe® Reader® (version 6.0 or higher) must be installed on the computer to view these reports.

  Reader® can be downloaded free of cost from http://get.adobe.com/reader (consult the System Administrator for assistance, if required).
- A conformance report opens in a different pop-up window.
  - Wait for the report to open. Do not immediately close the new window that pops-up.
  - It is imperative to allow the pop-ups to open in the web browser. The report will not open if the pop-ups are blocked. Pop-up settings in the third-party toolbar (if installed) also need to be changed accordingly.

USAID ECO-III Project

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